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FIELD CROP INSECTS

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and their CONTROL in the

Prairie Provinces

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FIELD CROP INSECTS
AND
THEIR CONTROL
IN THE
PRAIRIE PROVINCES

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FOREWORD

IT is now eleven years since the bulletin, entitled, "Field Crop Insects in the Prairie Provinces" was published by the Line Elevators Farm Service. The great advances in the science of entomology during this period, particularly in the field of insecticide control; and the increasing demand from farmers, country grain buyers, young farm people, agricultural students and others for a wider knowledge of the destructive insects of field crops and their control have made a completely new bulletin desirable.

In the preparation of this new bulletin two objects have been kept constantly in mind: first, to aid practical farmers, country grain buyers, 4-H Club members and other young farm people, agricultural students and others in the identification of the important insect enemies of field crops in the Prairie Provinces; and second, to make available, so far as possible in the limited space of a bulletin, up-to-date and reliable information on their control.

This bulletin has been written by A. V. Mitchener, B.A., B.S.A., M.Sc., Professor Emeritus of Entomology, The University of Manitoba. Professor Mitchener has made a study of insects his life's work. Through his teachings and writings he has won high recognition as an outstanding Canadian authority on economic entomology. The factual basis of this bulletin is based largely upon his 38 years as Professor of Entomology at The University of Manitoba. Many of the methods of control here recommended have been tested under his supervision. It is a pleasure for the Line Elevators Farm Service to acknowledge its indebtedness to Professor Mitchener for assuming the responsibility of preparing this publication. We also express our sincere thanks to Dr. R. D. Bird, Officer-in-Charge, Entomological Laboratory, Science Service, Canada Department of Agriculture, Brandon, Manitoba, for his invaluable aid in furnishing many excellent illustrations.

This bulletin is intended as a guide or reference handbook for farmers, grain buyers, extension workers and others. It is hoped that it will encourage young farm people to study not only those insects which are injurious to agriculture, but increase their interest in acquiring a wider knowledge of the insect world in general. The Line Elevator Companies, sponsors of the Line Elevators Farm Service, consider it a privilege to be able to offer this useful and informative bulletin to the agricultural public of Western Canada.

F. J. GREANEY,

Director, Line Elevators Farm Service.

FIELD CROP INSECTS AND THEIR CONTROL
IN THE PRAIRIE PROVINCES

A. V. MITCHENER

INTRODUCTION

INJURIOUS INSECTS

THESE insects take a heavy toll from the possible total returns from prairie farm crops every year. Not only do they destroy field crops but also they are carriers of virus, bacterial and fungus diseases of various plants which further add to our crop losses. These injurious insects are native species for the most part but some introduced species have become established as important pests. The introduced species are immigrants from other continents and have spread into the prairie provinces. New arrivals appear from time to time and possibly will continue to do so. Insects react differently to the changing annual environment and consequently a given species may be very abundant one year and of little importance the next.

In this publication insects have been separated into two groups, one of which includes the insects which, with a few exceptions of considerable interest, are of greatest importance. Information about insects in this group has been given in some detail. There will be some difference of opinion no doubt about the order of importance of the ten most destructive field crop insects in the area covered by the prairie provinces, but after consultation with some other western Canadian entomologists, the writer lists them in descending order of importance as follows: grasshoppers, wheat stem sawfly, cutworms, wireworms, Colorado potato beetle, aphids, sweetclover weevil, plant bugs, armyworm and beet webworm. Where the plural of the word is used more than one species of insect is involved. The other group of insects of lesser importance at this time at least across the prairies, has been arranged with information in tabular form indicating classification, distribution, crops attacked, the injurious stages of the insect, kind of injury, remarks and suggested control. Some of these insects may become major pests in the future.

BENEFICIAL INSECTS

Some of our insects such as the honey bee, bumble bees and leafcutting bees are very beneficial as they are pollinators of many of our important prairie field crops as well as fruit and other plants. For-

tunately for us most of our harmful insects have insect enemies. Those that hunt and devour their prey are called predators. There are others which lay their eggs upon their host insects and these are called parasites. Both predators and parasites are quite numerous and are very beneficial as they are important in assisting to keep injurious insects under control.

INSECT STRUCTURE AND LIFE STAGES

Adult insects have three pairs of legs and three parts to their bodies, namely, head, thorax and abdomen. The head bears the mouth parts, two antennae and the eyes. The thorax bears the six jointed legs and the two or four wings if the insect has wings. Some insects are wingless. The abdomens of some female insects bear a conspicuous ovipositor or egg-laying structure. Insects undergo a change in form and structure as they develop to the adult stage and this is known as metamorphosis. In general there are two types of metamorphosis, namely, simple and complete. In simple metamorphosis there are three stages known as egg, nymph and adult. The nymph often resembles the adult of the species, but has no wings. Both nymphs and adults are usually injurious. Examples of insects with simple metamorphosis are aphids, grasshoppers and true bugs of various species. Insects with complete metamorphosis have four stages in their life histories known as egg, larva, pupa and adult. Larvae do not look like the adults at all and are often incorrectly called worms. The pupal stage is a resting and transformation stage between the larval and the adult stage. Usually the larval stage is the most destructive although some adult insects are also harmful. Examples of insects with complete metamorphosis are cutworms, wheat stem maggot, wheat stem sawfly and wireworms.

The injurious stages of field crop insects feed either on solid pieces of the host plant or on its sap. Those insects which eat solid pieces have biting and chewing mouth parts, while those that feed upon plant juices have piercing-sucking mouth parts. Unfortunately there is no single control that may be used to kill all species of insects with either type of feeding habits.

CONTROL

Good farm cultural practices usually keep most insects under control except at times when the environment for a rapid increase in the population of a specific insect is especially suitable. Then it becomes necessary to employ insecticidal control. Insecticides may be applied

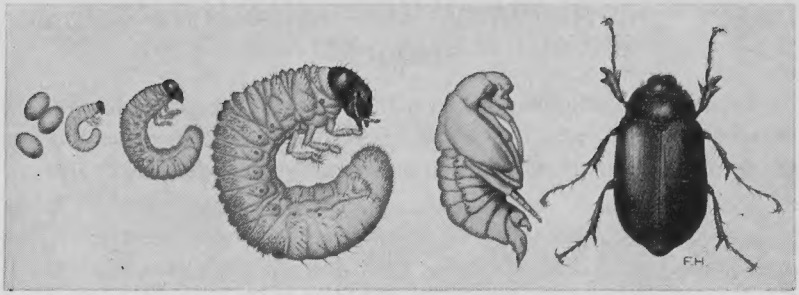

FIGURE 1—Egg, larval, pupal and adult stages of a June beetle, an insect with complete change in development. About natural size.

either as sprays or dusts. Poisons may be applied to the foliage, to the surface of the ground or incorporated with the soil depending upon the species of insect to be controlled. They may kill by being taken into the insect's stomach, by coming in contact with the insect's body, by the insect breathing the vapors coming from the insecticide or by a combination of these effects.

Few recommendations are given in this publication for definite amounts of insecticide to be used per acre. Insecticides are sold in different formulations. Farmers should follow the recommendations that are on the label of each package closely. Insecticides are poisonous to man and his animals as well as to insects and the greatest care must be taken in handling and storing them. The responsibility for safety rests with the person using the insecticide. Sprayers that have been used to apply weed killers must be cleaned thoroughly before being used for insecticides especially when being used to apply insecticide to crops which are susceptible to weed killers. Some varieties of specific farm crops are more resistant to insect attack than others. There is a great opportunity for the plant breeder and the entomologist to cooperate in producing still more insect resistant crops.

INSECT NAMES

The 1955 list of common and scientific names of insects published by the Entomological Society of America has been used for names that have been approved officially. A few of the insects mentioned have not been assigned common names as yet. Canadian entomologists contribute to this official list through the Entomological Society of Canada which is a nation wide organization. This list is under constant revision as additional insects by their activities come to the attention of entomologists.

INSECT IDENTIFICATION AND SUGGESTED CONTROL SERVICE

Farmers and other concerned with insect control should have every unrecognized injurious insect identified. Such identification services are available without cost in each prairie province as follows:

Manitoba— Federal Entomological Laboratory,
P.O. Box 250,
Brandon, Manitoba.
or
Department of Entomology,
The University of Manitoba,
Winnipeg, Manitoba.

Saskatchewan—Federal Entomological Laboratory,
c/o University of Saskatchewan,
Saskatoon, Saskatchewan.
or
Department of Biology,
University of Saskatchewan,
Saskatoon, Saskatchewan.

Alberta— Federal Entomological Laboratory,
Lethbridge, Alberta.
or
Department of Entomology,
University of Alberta,
Edmonton, Alberta.

Officers at any one of the above addresses have numerous bulletins and pamphlets dealing with specific insects and their control, which farmers, students and others will find interesting and helpful. In addition the local agricultural representative also has copies of many of these publications and can be of service in identifying injurious insects. Any insect that is new to him can be forwarded to one of the entomological headquarters in his province where assistance will be gladly given.

ACKNOWLEDGMENTS

As this is a popular publication no attempt has been made to give credit to the numerous federal and university entomologists who through many years of research and experimentation have studied insects and their control in the prairie provinces. The author is indebted to these fellow workers for information from their numerous publications which have been consulted and used freely. In addition to prairie entomologists, certain federal entomologists at Ottawa should be included. For many of the illustrations which brighten up the pages of this publication, credit is given to Dr. R. D. Bird, Entomological Laboratory, Science Service, Canada Department of Agriculture, Brandon, Manitoba.

KEY TO THE ORDERS OF INSECTS ATTACKING FIELD CROPS

ADULT INSECTS

1. With two wings 2
1a. With four wings 3
2. Wings membranous with relatively few veins and cells, two halteres or balancers replacing the hind wings; mouth parts for sucking, piercing-sucking or lapping; antennae variable; metamorphosis complete.
   Flies, gnats and mosquitoes ..... DIPTERA
3. Wings relatively long and narrow with few or no veins and held lengthwise on top of body when insect is at rest, wings fringed with long hairs; mouth parts fitted for rasping and sucking; antennae usually short; insects very small and somewhat difficult to see; metamorphosis intermediate between simple and complete.
   Thrips ..... THYSANOPTERA
3a. With four wings but not as in 3 4
4. Front wings similar to hind wings but larger, membranous with relatively few branching veins and cells; mouth parts usually fitted for chewing or chewing and sucking; antennae conspicuous; female usually has a sting, piercer or a saw-like ovipositor; metamorphosis complete.
   Ants, bees, sawflies, wasps and allies. See fig. 34 ..... HYMENOPTERA
4a. With four wings but not as in 4 5
5. Wings usually entirely covered with overlapping microscopic scales which rub off on the fingers if insect is handled, wings somewhat similar in form and relatively large with veins and cells not visible due to covering of colored scales; mouth parts in the form of a coiled proboscis when insect is at rest, proboscis used for sucking liquid food; antennae long; metamorphosis complete.
   Butterflies, moths and skippers.
   See figs. 16, 20, 21, 23, 24 ..... LEPIDOPTERA
5a. With four wings but not as in 5 6
6. Front wings horny or leathery and called elytra, without veins and usually meeting in a straight line down the middle of the back, hind wings membranous and usually folded crosswise and concealed under the elytra but when extended are usually longer than the elytra; mouth parts for chewing; antennae usually conspicuous and consist of numerous segments; metamorphosis complete.
   Beetles. See figs. 30, 31, 33 ..... COLEOPTERA

6a. With four wings but not as in 6..... 7

7. Front and hind wings unlike in structure, may be long or very short, front wings may be thickened, hind wings when at rest may be folded fan-like and may be translucent or colored; mouth parts for chewing; antennae long and consist of many segments; legs fitted for jumping or running; legs and wings may be modified for chirping or making other sounds; metamorphosis simple.
Cockroaches, crickets, grasshoppers and allies.
See figs. 2, 3, 4, 5, 10, 11.....ORTHOPTERA

7a. With four wings but not as in 7..... 8

8. Front wings thickened at bases and membranous at tips, wings lie flat on top of body and tips overlap when at rest, hind wings membranous and usually slightly shorter and wider than front wings, wing veins in membranous portion of front wing visible but not in basal half of wing; mouth parts arising at front of head and fitted for piercing-sucking; antennae may be long or short with five or fewer segments; metamorphosis simple. These are the only true bugs.
Chinch bugs, lygus bugs, plant bugs, stink bugs and allies.
See figs. 12, 13.....HEMIPTERA (HETEROPTERA)

8a. Front wings of uniform texture throughout and held roof-like over the abdomen with tips not or slightly overlapping when insect is at rest, hind wings often wider than the longer front ones, some forms wingless as aphids and female scale insects; mouth parts for piercing-sucking with beak arising at rear under part of head; antennae short or long with few segments; insects usually small; metamorphosis simple.
Aphids, leafhoppers, planthoppers, scale insects and allies.
See fig. 15.....HEMIPTERA (HOMOPTERA)

ORTHOPTERA

GRASSHOPPERS

A. IMPORTANCE AND DISTRIBUTION

Grasshoppers native to the area are the most important field crop insects in the Prairie Provinces of Canada. The first recorded occurrence of grasshoppers in this area was in 1799. These were the Rocky Mountain grasshoppers which migrated into Manitoba but did not become permanently established. It was not until 1898 that there is any record of our native species of grasshoppers occurring in destructive numbers. There are at least 75 species of grasshoppers occurring in

the three provinces but fortunately only a few of them ever occur in outbreak form. The four most important species are the migratory grasshopper[1], the two-striped grasshopper[2], the clear-winged grasshopper[3], and the Packard grasshopper[4]. Millions of acres of crops, involving the loss of countless millions of dollars, have been attacked during this century. Outbreaks caused by these species, each of which is widely distributed, seem to occur on the average in Manitoba at least, approximately every ten years and last approximately half of this period.

B. Plants Attacked and Kind of Injury

Wheat, barley and oat have suffered most from the attacks of grasshoppers although nearly every other field and garden plant or weed, especially perennial sow thistle, may serve as their food. From early in the growing season when the emerging crops are frequently completely destroyed, through harvest time and into late summer, grasshoppers continue to feed upon crop and other plants. During the early growing period the leaves of crops are eaten and later the ripening heads of grains may be severed. Infested pastures may produce relatively little forage for live stock.

FIGURE 2—Lesser migratory grasshopper. Adult female resting on Russian thistle. About twice natural size.
—*Photo R. D. Bird.*

[1] *Melanoplus mexicanus* (Sauss.), Order Orthoptera, Family Acrididae.
[2] *Melanoplus bivittatus* (Say), Order Orthoptera, Family Acrididae.
[3] *Camnula pellucida* (Scudd.), Order Orthoptera, Family Acrididae.
[4] *Melanoplus packardii* Scudd., Order Orthoptera, Family Acrididae.

C. Description, Life History and Habits

Since the various injurious species of grasshoppers have different habits, farmers and others should be able to identify each species. The following key should aid in recognizing the males of the four common injurious species and those of the Carolina grasshopper, which is a rather conspicuous species and widely distributed:

FIGURE 3—Female two-striped grasshopper. About twice natural size. —*Photo R. D. Bird.*

KEY TO SEPARATE THE MALES OF 5 COMMON SPECIES OF ADULT WINGED PRAIRIE GRASSHOPPERS

Notes: 1. The hind wings of the first 4 species mentioned in this key are semi-transparent.

2. See figure 4 for shape of the posterior end of the male abdomen. Compare this with figure 3.

A—Species having a short conical or cylindrical tubercle extending from the body between the bases of the front legs.

1. Two yellowish stripes extending from the top of the head over the pronotum and along the top of the folded wings to near their tips; hind tibia usually partly bluish or sometimes partly pinkish; about same size as Packard grasshopper but larger than the lesser migratory grasshopper; length of body 23-29 mm.—two-striped grasshopper—*Melanoplus bivittatus* (Say).

2. Longitudinal stripes on the outer edges of the top of the pronotum with central area of pronotum nearly black; stripes continuing along the top of folded wings, but less pronounced than on the two-striped grasshopper; hind tibia pale bluish-green or pink in color; length of body 22-30 mm.
—Packard grasshopper—*Melanoplus packardii* Scudd.

3. Yellowish stripes mentioned above absent; subanal plate of male with a distinct notch in the middle top aspect when insect is viewed directly from rear; hind tibia pale bluish-green; length of body 17-22 mm.

—migratory grasshopper—*Melanoplus mexicanus* (Sauss.).

AA—Species having no short conical or cylindrical tubercle between the front legs.

4. Two yellowish stripes extending from the hind margin of the pronotum along the tops of the folded wings to near their tips where the stripes merge; folded wings appear mottled with irregular shaped dark patches; tibia yellowish; length of body 17-21 mm.

—clear-winged grasshopper—*Camnula pellucida* (Scudd.).

5. Hind wing with central area black and outer border yellowish; length of body 24-33 mm.

—Carolina grasshopper—*Dissosteira carolina* (L.).

The life histories of all of the injurious grasshoppers are much the same. The winter is passed in the egg stage in the top inch or slightly more of the soil. Grasshopper eggs seldom begin to hatch much before May 24, but the hatching period may be delayed or prolonged into June if cool wet weather persists. On the other hand, early dry hot weather may hasten hatching. The young nymphs which emerge from the eggs are called hoppers and are wingless, but otherwise look similar to adult grasshoppers except that they are smaller. The nymphs grow through five or six stages called instars and at the end of each stage cast off an outer covering or exuviae, sometimes called a "skin." These exuviae sometimes collect in small depressions such as animal tracks in fields and may be mistaken for dead hoppers.

Usually adult grasshoppers begin to appear around July 1. Mating then takes place and the female grasshopper soon begins to lay her eggs. She first makes a hole by gradually working her abdomen full length into the ground. As she gradually withdraws her abdomen she lays her eggs in the hole and at the same time secretes a moist substance which later hardens and holds the batch of eggs together in a pod or case. Usually the clear-winged grasshopper completes her egg laying in August. The other species may continue to lay for another month or more. None of the eggs hatch until the following year. There is only one generation each year. Migratory grasshoppers prefer to scatter their egg pods throughout stubble fields. Two-striped grass-

hoppers prefer uncultivated land where they distribute their egg pods more sparsely in the soil. Clear-winged grasshoppers place their egg pods relatively close together in areas called egg beds. These usually are found in short grassed locations along fence lines, roadsides, pasture fields, headlands and similar places which are frequently near grain fields. Each such pod contains approximately 20 eggs. Hundreds of these egg pods may be found at times in a single square yard of sod. Packard grasshoppers prefer lighter soil for oviposition. When migratory grasshoppers and clear-winged grasshoppers are very abundant they frequently migrate long distances by flight and thus extend the area of infestation.

Among other species of native grasshoppers which fortunately are not considered injurious there are some whose eggs hatch in late summer and whose nymphs survive our winters. These nymphs become active in early spring shortly after the snow disappears and cause some concern to those who do not recognize them. To these people there appears to be an early outbreak of grasshoppers. Fortunately these grasshoppers never harm crops.

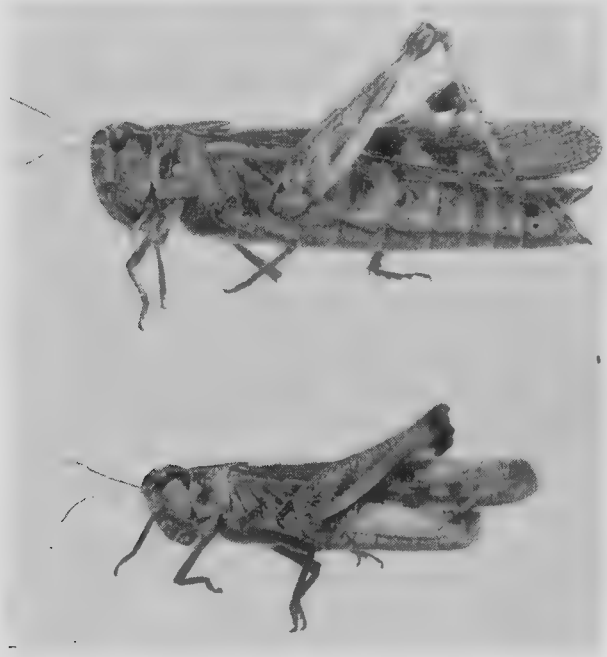

FIGURE 4—Clear-winged grasshopper. Female (above) and male (below). About twice natural size.
—*Photo R. D. Bird.*

One widespread and frequently observed species is the Carolina grasshopper[1] which is not considered to be a species of economic importance. The adults can be recognized easily by their hind wings which are black in the center and bordered with yellow. Their wings are relatively long and they are exceptionally good fliers.

FIGURE 5—Carolina grasshopper. —*Photo A. V. Mitchener.*

D. Control

Federal entomologists make an annual provincial adult grasshopper survey in summer and an egg survey in autumn, the results of which should be known to all farmers especially during outbreak years. Where danger of injury exists steps should be taken to keep farm land as free of grasshoppers as possible. Damage usually results from grasshoppers which emerge from eggs that were deposited the previous year on or near that farm. Seldom do grasshoppers lay their eggs on

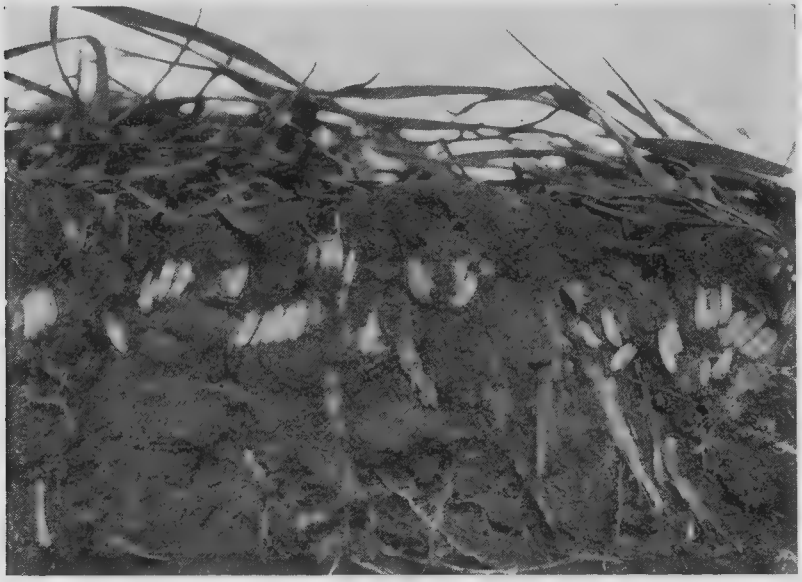

FIGURE 6—Clear-winged grasshopper. Heavy infestation of eggs in section of sod. About natural size. —*Photo R. D. Bird.*

[1]*Dissosteira carolina* (L.), Order Orthoptera, Family Acrididae.

summerfallow or among row crops. Much injury may result when young grasshoppers hatch from eggs deposited in short-grassed areas in fence rows, along roadsides, in headlands, in pasture fields and idle land or throughout stubble fields.

Grasshopper eggs can be destroyed by plowing down egg infested soil to a depth of six inches in autumn where this is practicable. Where plowing is not advisable due to soil drifting, surface cultivation to a depth of two inches will expose and destroy a large percentage of the eggs. Although such soil treatment is most effective when done in the autumn, similar control measures will destroy many of the eggs if done in early spring. Frequently countless numbers of egg pods are deposited in late summer in stubble fields which are to be summerfallowed the next year. Often these fields are left the following year until many of the hoppers have emerged. If these fields are not handled

FIGURE 7—Lesser migratory grasshopper nymphs congregating on a stone. Natural size. —*Photo R. D. Bird.*

FIGURE 8—Barley field severely injured by marginal invasion of two-striped and clear-winged grasshoppers. —*Photo R. D. Bird.*

properly they may become a source of much trouble. First a wide headland should be plowed or cultivated completely around the field to prevent the hoppers from moving out of the field. The field should then be worked lengthwise in strips on which the young hoppers will congregate. These green strips should then be sprayed with one of the insecticides suggested later. This should be completed before the first of the grasshoppers reach the winged stage as at that time they will fly from the field into surrounding crops.

Poison sprays applied to foliage to be eaten by the hoppers or the adult grasshoppers have now replaced almost entirely the poison baits which were used for so many years. Chlorinated hydrocarbon insecticides have taken the place of the arsenicals and fluosilicates which were formerly used in the baits. The chlorinated hydrocarbons most widely used at present are aldrin, chlordane, dieldrin and toxaphene. These poisons are sold in liquid form with varying amounts of toxicant in each gallon of each commercial product as indicated on each label. Sprays may be applied with any type of weed or other sprayer which will deliver a relatively low volume of approximately five gallons of prepared spray per acre. These insecticides are very poisonous and in general are recommended at the following amounts of actual toxicant in the amount of water that the sprayer will deliver per acre: aldrin 2 to 3 oz.; chlordane 8 to 16 oz.; dieldrin 1 oz. and toxaphene 16 to 24 oz. These amounts are indicated as a guide. Regional entomologists should be

FIGURE 9—A farm power sprayer used to control weeds and insects such as grasshoppers, cutworms and sweetclover weevil.
—*Photo Pioneer Grain Company Limited.*

consulted and their recommendations followed. Sprays should be applied on calm warm days if possible and great care should be taken to prevent the spray from blowing or drifting over the operator. If any spray should wet clothing or cover exposed parts of the body, soap and water should be used to clean the clothing and wash the hands and face. Dusts containing chlorinated hydrocarbons have been used but sprays are preferred by most farmers. If hatching in any area is prolonged the insecticides should be applied several times as necessary.

Poisoned baits may be used effectively where the vegetation is sparse and in gardens or wherever a sprayer cannot be used conveniently. The bait consists of 25 pounds of bran, $2\frac{1}{2}$ gallons of water and 2 ounces of actual aldrin or dieldrin. Mix the insecticide with the water and add this mixture to the dry bran in some container that will hold liquid and that can be cleaned readily after use. Stir continually until all the bran is moistened thoroughly and the whole mass has a fine crumbly texture. This amount of prepared bait is sufficient for two acres when broadcast by hand very thinly. Use rubber gloves on the hands. Repeat the application as necessary.

Female grasshoppers may lay a hundred or more eggs. Obviously it is only necessary to have two of these produce grasshoppers which reach the adult stage to maintain a given population. During the cycle when the population is increasing yearly, more must survive but even then it is evident that most by far of the eggs never produce mature grasshoppers. The weather plays an important part in keeping the grasshopper population under control. Cool wet weather in the early season delays hatching and the growth of the young hoppers. Similar weather later in the year prevents the maximum number of eggs from being laid. It is of interest here to observe that eggs will survive for weeks when covered with water early in the season. Damp weather favors the development of fungus and bacterial diseases. Ground beetles, tenebrionid beetles, bee fly maggots and blister beetle larvae feed upon the eggs. Parasitic flies infest adult grasshoppers. Red grasshopper mites occur on grasshoppers and among their eggs. Among the birds which eat grasshoppers, Franklin's gull ranks as one of the most important.

FIELD CRICKET[1]

A. Importance and Distribution

This insect which is native to the prairies although not a major field crop pest, may become very numerous in fields during some seasons in certain localities.

It is widely distributed but the records indicate that it has been most common in Manitoba.

FIGURE 10—Adult male field cricket. About twice natural size. —*Photo R. D. Bird.*

B. Plants Attacked and kind of Injury.

Cereals of all kinds are eaten. Flax bolls are often injured when field crickets are numerous. Heads of ripening crops may be severed. Where stook threshing occurs field crickets collect in the stooks and often pass through the threshing machine and come out in pieces with the

[1] *Acheta assimilis* F., Order Orthoptera, Family Gryllidae.

grain. Unless binder twine is treated field crickets may cut the bands in the stook. Occasionally field crickets enter houses late in the summer and when present may eat holes in clothing.

C. Description, Life History and Habits

The field cricket is black or nearly black in color and varies from three-fifths to one inch in length. The antenna is longer than the body and tapering. Like grasshoppers they are strong jumpers and difficult to catch although they cannot fly. The female may be distinguished by the presence of a posterior needle-like ovipositor or egg laying apparatus about as long as her body. Late in the summer she reaches maturity and lays her white eggs singly in the soil in stubble fields and elsewhere by means of her ovipositor which she thrusts full length into the ground. After laying one egg she moves to other spots for further egg laying. The winter is passed in the top inch of the soil in this stage. The eggs hatch the following summer somewhat later than grasshopper eggs. The young nymphs look similar to adult field crickets except that they have no wings. After molting several times the adult stage is reached late in the summer. There in one generation each year. Field crickets are most active at night although commonly observed especially when numerous, in daytime. The males only are capable of chirping, a noise which they make by rubbing the edges of their front wings together. Often a single male cricket in a house can be very disturbing. The ears of a field cricket are on its front legs. During years when field crickets are numerous they often cross roads and are crushed by passing traffic. Live crickets may be seen feeding on the bodies of their dead comrades, indicating their diverse food habits.

D. Control

Farm tillage practices usually keep field crickets under control as plowing or surface cultivation will destroy the eggs. As control is seldom required for the adults in fields, but rather for adult field crickets around buildings, poison sprays have not been used although no doubt they would be effective. Poison baits as used for grasshopper control have been very effective. Great care should be taken when scattering these baits around buildings to be certain that they are applied very lightly. Baits should be scattered in the evening for field cricket control. Field crickets are sometimes infested with thread-like white roundworms several inches long.

MORMON CRICKET[1]

A. Importance and Distribution

The Mormon cricket, a native insect, is wide-spread as scattered individuals over the southern prairies and on account of its size arouses curiosity, interest and even concern on the part of those who see it. In Western Canada it has never occurred in numbers sufficient to warrant control although in some states south of the international border it has occurred in outbreak form and has caused great damage to various crops. Apparently our climate prevents it from occurring in outbreak form here.

B. Plants Attacked and Kind of Injury

These insects feed upon nearly all kinds of field and garden crops as well as many kinds of weeds and shrubs. In Alberta in 1950 they

FIGURE 11—Adult female Mormon cricket. About natural size. —*Photo R. D. Bird.*

[1]*Anabrus simplex* Hald., Order Orthoptera, Family Tettigoniidae.

occurred in places along roadsides as numerous as two per square yard but usually only scattered specimens and no noticeable injury has been reported by observers across the prairies.

C. Description, Life History and Habits.

The Mormon cricket is not a true cricket but is related to a group of insects known as long-horned grasshoppers. The adults which vary in color from dark green to dark brown and are often mottled, are one inch or more in length, stout, rather clumsy insects with hind legs fitted for jumping. Their very short wings are useless for flying but on the males when rubbed together are used for making a chirping sound. The tapering, slender antennae are as long as the body. The female may be distinguished from the male by its long ovipositor extending from the rear end of its abdomen. The winter is passed in the egg stage in the top inch of the soil. Hatching takes place early in the season. Upon reaching the adult stage late in the summer the female inserts her ovipositor in the soil and leaves a single egg at each insertion. Mormon crickets are active during the heat of the day and seek shelter at night. Like field crickets they are cannabilistic. There is one generation each year.

D. Control.

Mormon crickets have not occurred in economic numbers on the Canadian prairies and no control is recommended. No doubt ground and plant sprays used for grasshopper control would be effective. Gulls as well as other birds and many small mammals help to reduce their numbers.

HEMIPTERA (HETEROPTERA)

WESTERN CHINCH BUG[1]

A. Importance and Distribution

This native insect is not a major crop pest but where it does occur it causes very definite and conspicuous damage especially to the edges of wheat fields. Records indicate that it occurs in Manitoba where it was recorded for the first time in 1931 in the Red River Valley and in south central and south western Saskatchewan.

B. Plants Attacked and Kind of Injury

Every outbreak studied has had its origin in an old brome grass pasture or other brome grass area. Wheat and barley fields adjoining these pastures have been attacked. Brome grass pastures have been conspicuously thinned out through the years to the point that the pasture has become almost useless. The insects feed on the sap of the

[1]*Blissus occiduus* Barber, Order Hemiptera (Heteroptera), Family Lygaeidae.

host plants which become brown and die. Injury to grain fields has occurred almost always during the last week of May and the first two weeks of June in Manitoba.

C. Description, Life History and Habits

The adult western chinch bug is about one-eighth inch in length. Two forms, one fully winged and the other with short wings, occur at the same time. The membranous parts of the front wings of the former form are milky in color. The under side of the body of each form is dark brown. The nymphs are reddish in color. All have piercing-sucking mouth parts and feed entirely upon plant sap which they obtain by piercing the plant tissue. The complete life history has yet to be studied but probably the winter is spent either as an adult or nymph at the surface of the soil around brome grass plants. Populations build up in old brome grass fields resulting in overcrowding and a movement of the insects into an adjoining field follows. As they move into the field they destroy all the plants as they advance and from a distance the edge of the field appears as if it had been invaded by the clear-winged grasshopper. The bare ground may extend several rods into the crop. A superficial examination of the surface of the ground may fail to reveal the presence of any insects as they work beneath the surface of the soil next to the plant stems where they feed upon the sap. By moving the soil away from the dying plants the small insects may be seen readily.

D. Control

Plow down old infested brome grass pastures. When the insects invade a grain field plow the infested margin of the field to bury the insects. The plowing should extend several rods beyond the bare dead area since many of the bugs will be working where the crop is still green but stunted. If it is not too late in the season barley may be sown on this plowed area after it has been made ready for the seeder. This control has been very effective in destroying these insects.

LYGUS BUGS[1, 2]

A. Importance and Distribution

These native insects all occur on alfalfa in each of the prairie provinces. At least some of them by their feeding habits both in the

[1] *Liocoris borealis* Kelton, Order Hemiptera (Heteroptera), Family Miridae.
Liocoris desertus (Knght.), Order Hemiptera (Heteroptera), Family Miridae.
Liocoris rubroclarus (Knght.), Order Hemiptera (Heteroptera) Family Miridae.
Liocoris rubrosignatus (Knght.), Order Hemiptera (Heteroptera), Family Miridae.
Liocoris rufidorsus Kelton, Order Hemiptera (Heteroptera), Family Miridae.
Liocorus unctuosus Kelton, Order Hemiptera (Heteroptera), Family Miridae.
[2] *Lygus lineolarius* (P. de B.), Order Hemiptera (Heteroptera), Family Miridae.
Note—If a petition submitted by Hemipterists to the International Commission on Zoological Nomenclature is approved the genus *Liocoris* will be placed in the genus *Lygus*.

nymph and adult stages prevent normal seed production in many areas where alfalfa is grown for seed. They are not considered at present to be of great economic importance where alfalfa is grown only for feed.

B. Plants Attacked and Kind of Injury

Alfalfa is the field crop most seriously affected although many other plants are hosts of the various species of this group of insects. Only the tarnished plant bug[2], which is probably the most abundant species and which has a great variety of host plants, has as yet been given a common name. All seven species may be considered to be general feeders. They have piercing-sucking mouth parts and feed upon plant sap. It is believed that they introduce a toxic substance into the plant while in the act of feeding. As a result of their feeding habits at least some of these lygus bugs prevent many alfalfa flower buds from opening and cause other flower buds and seed pods to fall. Seed pods which do not fall may contain shrivelled useless seeds.

C. Description, Life History and Habits

In general the various species of adult lygus bugs measure approximately one-quarter of an inch in length or slightly less. The different species vary in color through hues of green, brown, red to black. They are flattened, oval, true bugs with the tips of their front wings membranous in texture. There are three stages in their life histories, namely, egg, wingless nymph and four-winged adult. All species pass the winter in the adult stage in hibernation in sheltered places. Although most of their life histories are not known as yet, it is likely that each species has only one generation each year.

D. Control

Burn over alfalfa stubble and old weed patches which may harbor hibernating adults before new growth starts in the spring. Alfalfa fields infested with lygus bugs and intended for seed production should be sprayed or dusted with DDT while still in the bud stage before any bloom appears. Alfalfa should not be sprayed or dusted when in bloom as this will destroy native leaf-cutting bees, bumble bees and honey bees which are pollinators of alfalfa. If an insecticide must be applied when the plants are in bloom, do this in the late evening or early morning when pollinating insects are not active. Without the visitations of insect pollinators, alfalfa will set very little seed. Alfalfa plants which have been sprayed or dusted with an insecticide should not be used as feed for animals.

ALFALFA PLANT BUG[1]

A. Importance and Distribution

This insect which was introduced into North America was first reported in Manitoba in 1941 and since that time has spread into Saskatchewan. It probably found its way into prairie Canada from the northern states although it was first reported on this continent in Nova Scotia in 1917. Its feeding habits make it a pest of economic importance in alfalfa fields kept for seed production.

B. Plants Attacked and Kind of Injury

Alfalfa is its principal host. Its piercing-sucking mouth parts are inserted into growing plant tissue, flower buds, flowers and the green seed pods from which the plant sap is sucked, resulting in seed producing parts which turn yellow, die and fall. It is probable that when feeding, the bug introduces some substance toxic to the plant which along with sap consumption limit seed set in alfalfa.

FIGURE 12—Alfalfa plant bug. Adult. About six times natural size.
—*Photo C. L. Morier.*

C. Description, Life History and Habits

The adult alfalfa plant bug is greenish-yellow, about one-third inch long and about one-third as wide. The yellowish eggs which are about one-twentieth of an inch long are inserted mostly in the stems of alfalfa plants although they have been found in the stems of sweet clover. Each female may lay as many as 60 eggs in irregular rows with only the egg caps showing on the surface of the plant stem. The light green nymphs emerge from the over-wintered eggs around the first of June. Later these turn brown and reach the adult stage near the end of June or early July. These first generation adults lay their eggs in the stems a foot or more above ground and a second generation is produced. In

[1] *Adelphocoris lineolatus* (Goeze), Order Hemiptera (Heteroptera), Family Miridae.

general in summer the eggs hatch in about two weeks and the nymph stage lasts three or four weeks. The eggs laid by the second generation adults, which are inserted much nearer the ground in alfalfa stems than those laid by first generation adults, lie dormant in that stage throughout the winter. There are two generations each year.

D. Control

Burn alfalfa stubble thoroughly in early spring before any new growth appears. This destroys the overwintered eggs which were deposited in the old stems. Do not leave unburned patches as these will provide sources of infestation later in the season. Observe all local regulations about setting fires at that time of year and be careful to avoid having the fire get out of control. Spray or dust alfalfa crops which are to be kept for seed with DDT according to local provincial recommendations just before the first alfalfa flowers open in the field. Sprayed or dusted alfalfa should not be fed to animals.

SAY STINK BUG[1]

A. Importance and Distribution

This native insect was first recorded as injurious to crops in Alberta in 1935. Its numbers and injury increased from that time until 1943 during which time the area involved increased to include southwestern Saskatchewan with much damage to wheat. Since that time with the

FIGURE 13—Say stinkbug. Adults. About three times natural size. —*Photo R. D. Bird.*

[1]*Chlorochroa sayi* Stal., Order Hemiptera (Heteroptera), Family Pentatomidae.

FIGURE 14—Say stinkbug. Eggs. About six times natural size.
—*Photo R. D. Bird.*

exception of 1949 the insect has occasioned little crop loss. The insect has been of no economic importance in Manitoba.

B. Plants Attacked and Kind of Injury

Wheat has been most severely damaged by Say stink bug although oat, barley, rye, flax, alfalfa, bean, pea, sunflower, grasses and garden crops have also served as food plants for the insect. It is a sap feeding insect and feeds upon the developing kernels in the wheat head resulting in a shrunken and light weight sample of grain. The heads which are attacked do not show evidence of injury, and usually the results of this feeding are not recognized by farmers until the crop is harvested.

C. Description, Life History and Habits

The adult in summer is a shield-shaped, bright green typical pentatomid bug about one-half inch long by one-quarter inch wide with three small spots on the front margin of the scutellum. The green coloration of summer becomes dark brown during the hibernation period. The adults which can fly freely from field to field and which winter over in clusters under dead weeds and trash become active as soon as the weather warms up in spring when they feed upon the sap of weeds and grasses. Egg laying usually occurs by the middle of May. The small eggs are grayish white and are laid in

clusters of 14 to 30 on stubble, dead weeds and growing vegetation. The wingless young or nymphs are brown or black in color but gradually turn green as they grow through five instars to become winged adults approximately the first week of July. After this they lay eggs for a second generation, the adults of which appear during the second week of September. There are two generations each year.

C. Control

Burn old dead weeds and trash along roadsides, fence lines, etc., in early spring while the adults still congregate in such places for protection. Burning should be done in the early morning before the insects leave these spots. Where the bugs are numerous throughout stubble fields they may be destroyed by plowing where this is practicable.

HEMIPTERA (HOMOPTERA)

APHIDS

A. Importance and Distribution

This group of native insect species is an important one on field crops, especially during some summers. In addition to field crops, aphids also attack vegetable crops, fruits, trees and flowers so that we may consider their many species as a group, as among our most injurious insects. Some species are known to carry plant diseases from plant to plant. Several species are involved in the outbreaks on various farm crops across the Canadian prairies. Cereals are attacked by the greenbug[1] which is especially destructive to late sown crops in Manitoba and Saskatchewan. Other aphids which occur on various field crops are the corn leaf aphid[2] and the English grain aphid[3]. The pea aphid[4] occurs on field peas in Manitoba where they are grown to be processed into soup and on peas grown in Alberta for canning purposes. This species also occurs on alfalfa and clovers across the prairies but as yet is not considered especially destructive to these crops. The sugar-beet root aphid[5] occurs on sugar-beets in Alberta and probably in Manitoba.

[1] *Toxoptera graminum* (Rond.), Order Hemiptera (Homoptera), Family Aphidae.
[2] *Rhopalosiphum maidis* (Fitch), Order Hemiptera (Homoptera), Family Aphidae.
[3] *Macrosiphum granarium* (Kby.), Order Hemiptera (Homoptera), Family Aphidae.
[4] *Macrosiphum pisi* (Harr.), Order Hemiptera (Homoptera), Family Aphidae.
[5] *Pemphigus betae* Doane, Order Hemiptera (Homoptera), Family Aphidae.

B. Plants Attacked and Kind of Injury

The greenbug and the English grain aphid attack cereal crops such as wheat, oat and barley, especially late-sown crops. The corn leaf aphid occurs on barley and corn. Each of these species may live on many cultivated and wild grasses. The pea aphid infests plants of both field and garden pea, alfalfa and the various clovers. The sugar-beet root aphid is found on the underground part of sugar-beet.

FIGURE 15—Cornleaf aphid attacking barley. About natural size. —*Photo R. D. Bird.*

Aphids have slender piercing-sucking mouth parts which they insert into the plant tissue and then suck the plant sap for food. Their rapid reproduction may result in enormous populations which deplete the crops of their plant juices resulting in wilting, abnormal growth and even death of the plants. In general aphids live on one host

plant for part of the summer and then migrate to an alternate host where they continue to increase in numbers. In 1955 one of the worst aphid infestations in prairie history appeared in Manitoba in early July, especially on barley, and moved westward across Saskatchewan and into Alberta by the third week of July.

C. Description, Life History and Habits

Different species of aphids vary in form, color, size, life history and habit. In this discussion the general features of the topic only will be given as little local study has been given to our injurious species. The life histories are complicated and the species so much alike in many instances that they are difficult to identify. In general, aphids are small, pear-shaped, soft-bodied insects, usually green in color and may be either winged or wingless. Their bodies which are about as large as a pin-head bear near the back end two short growths known as cornicles. At least some of our aphid species winter over in the egg stage. When vegetation begins to turn green after the winter, these tiny eggs hatch into wingless aphids known as stem-mothers which are all females and which give birth to living female aphids without mating. These female young (there are no males until late in the season) in turn give birth to living female young and this continues for several generations. Eventually some winged individuals are produced which fly to other plants where the same type of reproduction continues. Towards the end of the summer true winged males and females are born. These mate and the females lay eggs usually on some perennial host and the species is carried through the winter in that stage. Aphids are noted for their production of a sticky substance from their alimentary tracts known as honeydew. This excretion is much relished by many other insects. This is a simplified life history of the most common type of aphid. It is doubtful if the greenbug, the corn leaf aphid or the English grain aphid overwinter on the Canadian prairies. It seems more probable that our severe outbreaks result from migrations from the South in the early part of the summer, which after a few generations here on our crops, develop into the intense infestations which occur on our cereals from time to time. The pea aphid may or may not overwinter in the egg stage on alfalfa in western Canada. Elsewhere the sugar-beet root aphid overwinters in the egg stage on poplars. Many people have observed swarms of tiny winged insects in the air on warm, quiet days in late autumn. These swarms are the males and females of some abundant species of aphid. Aphids

which attack our field crops merit much more study than they have received in the past. Some varieties of barley elsewhere have shown a high degree of resistance to greenbug attacks.

D. Control

Early sowing of cereals is recommended as aphids damage late-sown crops most severely. Crops grown on well cultivated and fertilized soil will be vigorous and are more likely to withstand insect attacks than less healthy crops. Malathion used according to the manufacturer's directions is recommended for the control of aphids on field crops. Nicotine sulphate is also effective in controlling aphids in gardens and home grounds. Always follow the directions which appear on the label attached to the container of every insecticide. Syrphid fly larvae and lady beetles, both larvae and adults, are important predators of aphids and tiny braconid wasps often parasitize them. Weather conditions have an important bearing upon aphid populations.

POTATO LEAFHOPPER[1]

A. Importance and Distribution

The potato leafhopper is a native North American insect which merits the attention of Manitoba potato growers even though it does not appear in injurious numbers every year. When abundant it causes potato foliage to ripen prematurely which greatly reduces the size and yield of the potato crop.

B. Plants Attacked and Kind of Injury

Although this insect is known to feed on many different species of plants, its injury here is largely confined to the potato. It has also been found on apple in Manitoba. It has piercing-sucking mouth parts and feeds through the lower surfaces of the leaf veins by sucking sap from the plant. In doing this it destroys the plant tissue making up the tiny tubes which transport the plant sap and thus prevents the leaves from receiving a normal supply of plant sap which results first in the tips of the leaves turning brown and later in the whole leaf drying out. This condition is known as hopperburn. As the potato leaves become more and more affected they curl upward at the edges, become browner and in severe cases the plants die prematurely.

[1]*Empoasca fabae* (Harr.), Order Hemiptera (Homoptera), Family Cicadellidae.

C. Description, Life History and Habits

Adult potato leafhoppers are green, about one-eighth inch long, broad at the head end and taper towards the tips of the wings. The nymphs are smaller and are wingless. Both stages may be distinguished from aphids with which they may be confused by their quick movement on the undersides of the leaves. Aphids usually move very slowly if at all when under observation, while potato leafhoppers move actively sidewise or even backward and the adults fly readily. The hind tibiae bear two rows of spines which are absent on aphids, but a magnifying glass is needed to see them as well as the characteristic six white spots on the top of the body just back of the head. It is believed that potato leafhoppers do not overwinter in any stage on the Canadian prairies. An outbreak results when adults are carried north by southerly winds. First adults have been observed during late June and early July in Manitoba. These winged migrants soon begin to lay eggs in the veins of potato leaves. The life history of this insect has not been studied on the prairies but elsewhere the whitish eggs about one twenty-fourth inch long hatch in about 10 days and in a further two weeks become adults. This relatively short period for development may result in a rapid increase in the population and a fairly quick deterioration of the potato foliage.

D. Control

The potato leafhopper may be controlled with a spray containing DDT alone or in combination with a fungicide if late blight is a problem. DDT may be used also as a dust. Toxaphene is also recommended to control this insect on potato.

LEPIDOPTERA

ARMYWORM[1]

A. Importance and Distribution

Outbreaks of the armyworm, which is a native insect, occur at irregular intervals, quickly and without warning. While damage is usually not extensive it may be quite important to individual farmers. Outbreaks have been confined largely to southern Manitoba and eastern Saskatchewan.

[1] *Pseudaletia unipuncta* (Haw.), Order Lepidoptera, Family Phalaenidae.

FIGURE 16—Adult armyworm moth. About twice natural size.
—*Photo R. D. Bird.*

B. Plants Attacked and Kind of Injury

The most severe and widespread armyworm outbreak for many years occurred in 1954. In Manitoba the most serious occurrence was in the Red River Valley and along the west side of Lake Winnipeg, where the armyworm appeared on many farms. Most of the outbreaks originated near farm buildings in grass, especially couch grass, but many bad outbreaks occurred in pasture fields. Barley, brome, corn, oat, rye and wheat are attacked severely, often by migrating larvae. First these climbing larvae eat the leaves of their host plants. Later oat kernels may be cut from the heads of that crop and whole heads may be severed from other grains. Pasture fields may be impaired and in some instances lawns have been injured.

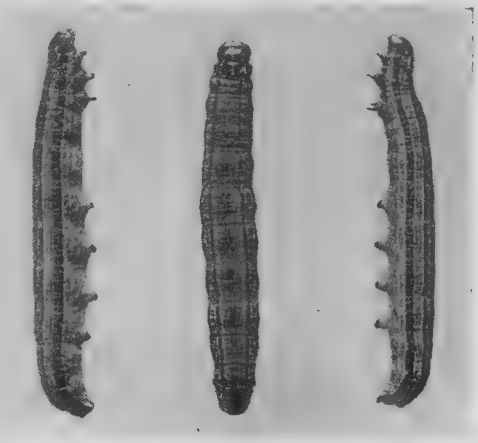

FIGURE 17—Armyworm larvae. About natural size.
—*Photo Dominion Department of Agriculture.*

C. Description, Life History and Habits

The adult moth, which has a wing spread of approximately one and one-half inches, is pale brown or brownish-gray in color with one small white spot

near the middle of each front wing. The greenish-white eggs are laid on the lower leaves of grasses or grain and hatch in a few days into small green larvae with a looping movement which are seldom noticed. The growing larvae become greenish-brown in color and viewed from either side are marked by three longitudinal stripes, the center one being dark brown with a lighter colored one both above and below it. Fully grown larvae may be nearly two inches in length and when they reach that size will do little further damage. Pupation takes place in the top soil in cells made by the larvae. The naked pupae are brown in color and approximately three-quarters of an inch in length. The life history of the armyworm has not been studied thoroughly in the prairie provinces, partly because the outbreaks occur irregularly. Farther south the insects are said to overwinter as partially grown larvae. It seems probable that our outbreaks are due to a northerly June migration of moths which lay their eggs here on native and other members of the grass family. In 1954 the first reports of damage were received on July 15 in Manitoba and many of the larvae at that time were nearly full size. The peak of the farmer interest in the outbreak occurred around the end of the third week and the beginning of the fourth week of July and it slowed up after July 26. Adults

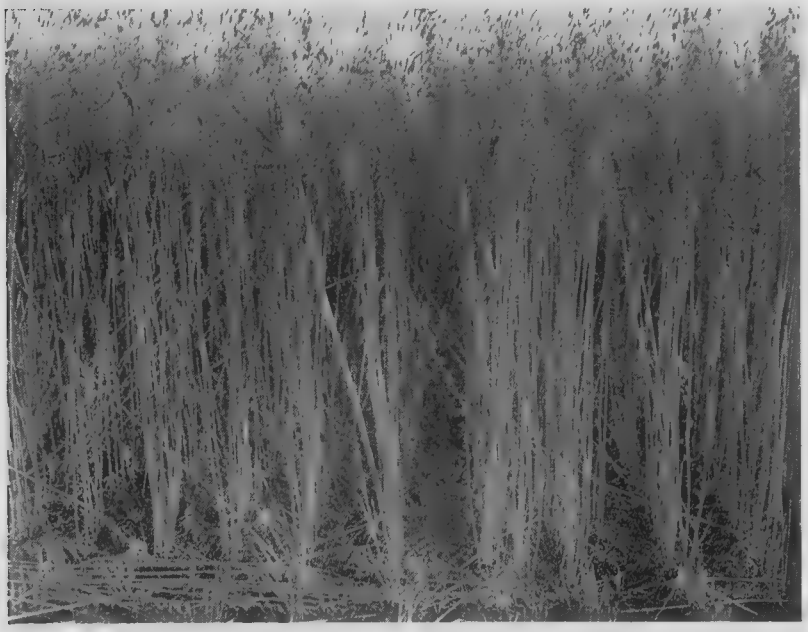

FIGURE 18—Oats stripped of leaves by armyworms.
—*Photo R. D. Bird.*

FIGURE 19—Ditch ploughed to trap advancing armyworms.
—Photo R. D. Bird.

which are readily attracted to light, were taken in numbers from light traps at the end of the third week of August. No reports of any damage due to the larvae from these adults were received later in the year. Armyworm moths lay many of their eggs on grass near fields of grain. The young larvae eat relatively little compared with those nearing maturity when very conspicuous injury occurs. Very quickly the grass food supply may fail and it is at this time that the larvae suddenly may begin to march in one direction in search of more food. It is because of this habit that the armyworm gets its name. When an army of these nearly mature larvae enters a grain field or a garden they can do much damage in a very short time.

D. Control

Either sprays or baits may be used to control armyworms, depending upon local conditions. A spray containing aldrin, DDT or toxaphene applied to crops to be protected is effective. Care must be taken that animals are not allowed to pasture on sprayed grass or grain. A bait made from 25 lbs. bran, one ounce actual aldrin and two and one-half gallons of water is also effective. Mix the emulsifiable formulation of aldrin with the water and add this to the dry bran. Mix very thoroughly until all particles of the bran are dampened. This fifty pounds of prepared bait should be sufficient for two acres when

scattered by hand thinly where the armyworms are feeding. Armyworms on the march may be controlled by either sprays or baits. Plowing furrows at right angles to the line of march, towards the approaching larvae, and scattering bait in them has given good control. Tachinid flies are parasites of the larvae.

PALE WESTERN CUTWORM[1]

A. Importance and Distribution

This native cutworm has destroyed crops at frequent intervals since the first outbreak occurred in Alberta in 1911. It is widely distributed in Saskatchewan and Alberta on the open prairie. Its

FIGURE 20—Pale western cutworm. Adult. About 2½ times natural size.
—*Photo R. D. Bird.*

occurrence in Manitoba was first reported in 1952, where as yet it has been of very little economic importance. Recent records indicate that in general this insect has been less destructive during the past several relatively moist years than formerly when during certain dry years it was an insect of major importance.

B. Plants Attacked and Kind of Injury

Barley, flax, oat and wheat have been most severely injured by pale western cutworm. The larval stage only is injurious. Whole fields of crops may be destroyed when the larvae are numerous.

[1] *Agrotis orthogonia* Morr., Order Lepidoptera, Family Phalaenidae.

C. Description, Life History and Habits

The adult is a moth having a wing expanse of approximately one and one-quarter inches. The general color of its wings is light brown marked with darker areas. Adults feed upon the nectar of flowers. The whitish spherical eggs are so tiny that they are not noticed. The young larvae are small and almost colorless but turn to a uniform pale

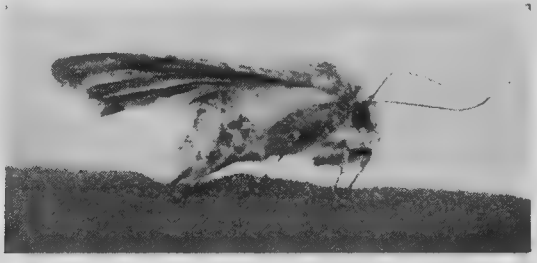

FIGURE 21—Pale western cutworm laying eggs in loose soil. About twice natural size.
—*Photo H. L. Seamans.*

gray as they grow to attain a length of approximately one and one-half inches when fully grown. The pupae are dark brown in color. The moths are on the wing from about August 10 to September 15 during which time the females lay their eggs in soft soil. Normally the winter is passed in the egg stage. Hatching occurs in the spring when the top soil thaws out. First instar larvae feed upon new growth above ground for approximately ten days but soon go beneath the surface of the soil to feed until towards the end of June. Mature larvae make earthen cells about three inches below the surface of the ground and change to pupae. Adults begin to emerge approximately during the second week of August. There is one generation each year. The larval habit of living underground during the most of their lives and especially when they do most damage makes control with poisoned baits ineffective. Entomologists in Saskatchewan and Alberta issue annual forecasts on the possibilities of an outbreak the following year.

D. Control

This includes the prevention of egg laying in the field, starving the young larvae after they have begun to feed and using some of the newer insecticides as ground sprays. As female moths lay their eggs only in soft soil it is recommended that land should not be cultivated between August 1 and September 15. Complete the destruction of weeds by the end of July and leave the land undisturbed. A crust

on the surface of the soil will prevent the moths from ovipositing. Farm animals should be kept out of these fields as even hoof tracks will attract the moths which are looking for suitable soft earth for egg laying. After the recently hatched cutworms have fed for a few days they may be starved in a field where they have hatched by destroying their food by cultivating the field. Delay this cultivation until growth (except stinkweed) is from one to two inches above ground. Then destroy all growth by cultivation. For this to be effective the young larvae must have fed for a few days, otherwise they can live for a time without food. Delay seeding ten days after cultivation has been completed. The emulsion formulation of the newer insecticides such as dieldrin, endrin and toxaphene and probably others are effective when applied as sprays to the surface of the soil in fields when damage is first noticed. These insecticides may be applied with low volume sprayers used to control weeds. Sprayers must be thoroughly cleaned before being used to apply an insecticide. Consult the Entomological Laboratory in your province for its forecast on areas likely to be infested with pale western cutworm and obtain further detailed advice on control.

RED-BACKED CUTWORM AND ASSOCIATED SPECIES

A. Importance and Distribution

The red-backed cutworm[3] is the most important cutworm of this group. It occurs most frequently and its distribution is most widespread. It occurs in all three prairie provinces, especially in the park areas, but also on the open prairies. This cutworm attacks not only field crops but also garden plants of many kinds. The striped cutworm[4] occurs in Manitoba and Saskatchewan. The sand cutworm[1] occurs in Saskatchewan while the dingy cutworm[5] as well as the dark-sided cutworm[2] have been injurious in Manitoba. Other species also occur in injurious numbers in various parts of the prairies.

B. Plants Attacked and Kind of Injury

Crops of barley, flax, oat, pea, rye, sugar-beet, sunflower, wheat and white and yellow sweet clover have each been injured by cut-

[1] *Euxoa detersa* (Wlk.), Order Lepidoptera, Family Phalaenidae.
[2] *Euxoa messoria* (Harr.), Order Lepidoptera, Family Phalaenidae.
[3] *Euxoa ochrogaster* (Guen.), Order Lepidoptera, Family Phalaenidae.
[4] *Euxoa tessellata* (Harr.), Order Lepidoptera, Family Phalaenidae.
[5] *Feltia ducens* Wlk., Order Lepidoptera, Family Phalaenidae.

worms. Larval damage is done early in the season by cutting off the stem of the plant at about ground level.

C. Description, Life History and Habits

In general, adult cutworm moths, which are sometimes called millers, are dull gray to brown in color but vary in appearance even within a particular species. They have a wing expanse of approximately one and one-half inches. Each female can lay several hundred eggs which are very small and seldom noticed. The larvae of the different species are variously marked but in general are a dull gray in color. The red-backed cutworm is distinguished by two dull reddish stripes extending along the back. A fully grown cutworm may be one and one-quarter inches or slightly more in length. Each larva has three pairs of pointed true legs near the head end and five pairs of fleshy prolegs along the under side of the posterior half of the body. The pupa is brown in color. The eggs are laid in the soil in August and do not hatch until the first warm weather comes the next spring. As larvae in the early instars eat relatively little food compared with the amount eaten by older larvae they are seldom noticed until near the middle of May. Most severe damage continues from about the beginning of the fourth week of May until about the end of the third week in June although damage by the dark-sided cutworm may continue for nearly another week. The period of damage varies somewhat with seasonal weather conditions. After reaching maturity the larvae enter the soil a few inches, excavate cells and then change into pupae. Moths emerge during the last half of July and early August after which mating and egg laying occurs. There is one generation each year. The moths which are attracted to lights seem to prefer the lighter soils for egg laying. Cutworms do most damage when the

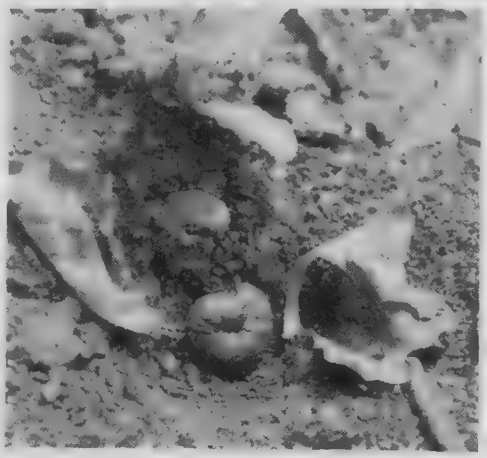

FIGURE 22—Red-backed cutworm larva in a typical curled up position after having been disturbed. Less than natural size.
—Photo R. D. Bird.

nights and days are warm and are inactive during cold weather. They come to the surface of the ground at night when they move around until they find food. After feeding they burrow into the top soil near where they fed and remain there during the day. When disturbed they have a habit of curling up and feigning death. Cutworms are also very destructive in gardens throughout the prairie provinces.

D. Control

Ground sprays containing aldrin, chlordane, dieldrin or toxaphene are very effective in controlling cutworms in field crops. Not only are they effective, but also they are easily and quickly applied with the farm sprayer used for weed control. The emulsion formulation of the insecticide is recommended as no particles are left in suspension in the spray tank to clog spray nozzles. The spray should be applied on a day which promises to be followed by a warm night which will bring the cutworms to the surface of the ground in search of food. In crawling over the sprayed ground, even though as little as five or six gallons of spray containing the amount of insecticide recommended per acre by the manufacturer have been applied, cutworms will be killed readily by coming in contact with the sprayed ground surface. Sprayers which have been used to apply herbicides must be thoroughly cleaned before being used for insecticides.

In restricted areas and in gardens where sprays cannot be applied conveniently a poisoned bait is very effective. Twenty-five pounds of dry bran, two and one-half ounces of actual aldrin or dieldrin and ten quarts of water make a good poisoned bait. Mix the emulsion formulation of the poison thoroughly with the water and add this to the bran and mix thoroughly until every particle of the bran is damp. This amount of prepared bait will weigh approximately fifty pounds and will be sufficient to cover two acres when scattered evenly and thinly by hand on the ground. Apply the bait during a warm evening. The newer insecticides immobilize and kill cutworms quicker than the poisons used formerly. Wash the hands with soap and water after handling poisoned bait. Keep all poisons clearly labelled and away from children. If reseeding a field is necessary it may be done soon after the spray or poisoned bait has been applied. Ground beetles, parasitic insects, Franklin's gull and disease assist in keeping cutworms under control.

TABLE I—FIELD CROP INSECTS OF LESSER ECONOMIC

COMMON NAME OF INSECT	SCIENTIFIC: NAME	ORDER FAMILY	DISTRIBUTION M—Man., S—Sask., A—Alberta	PRI FIEL ATT
GRASS THRIPS	*Anaphothrips obscurus* (Müll)	Thysanoptera Thripidae	A	barley
RAPID PLANT BUG	*Adelphocoris rapidus* (Say)	Hemiptera (Heteroptera) Miridae	M – S	alfalfa
SUPERB PLANT BUG	*Adelphocoris superbus* (Uhl.)	Hemiptera (Heteroptera) Miridae	A	alfalfa
RAGWEED PLANT BUG	*Chlamydatus associatus* (Uhl.)	Hemiptera (Heteroptera) Miridae	M	sunflow
A PLANT BUG	*Plagiognathus* sp.	Hemiptera (Heteroptera) Miridae	S	alfalfa
WESTERN WHEAT APHID	*Brachycolus tritici* Gill.	Hemiptera (Homoptera) Aphidae	S — A	agropyr winter
POTATO APHID	*Macrosiphum solanifolii* (Ashm.)	Hemiptera (Homoptera) Aphidae	M	potato
SIX-SPOTTED LEAFHOPPER	*Macrosteles fascifrons* (Stal)	Hemiptera (Homoptera) Cicadellidae	M — S — A	bean, f potato,
TIGER MOTH CATERPILLARS	*Apantesis* spp.	Lepidoptera Arctiidae	S — A	alfalfa, wheat
PAINTED-LADY	*Vanessa cardui* (L.)	Lepidoptera Nymphalidae	M — S	Canada sunflow
BLACK ARMY CUTWORM	*Actebia fennica* (Tausch.)	Lepidoptera Phalaenidae	M — A	alfalfa, red fesc
ARMY CUTWORM	*Chorizagrotis auxiliaris* (Grote)	Lepidoptera Phalaenidae	M — S — A	flax, m
WHEAT HEAD ARMYWORM	*Faronta diffusa* (Wlk.)	Lepidoptera Phalaenidae	S — A	barley, rye, wh
FLAX BOLLWORM	*Heliothis ononis* (D. & S.)	Lepidoptera Phalaenidae	S	flax
CORN EARWORM	*Heliothis zea* (Boddie)	Lepidoptera Phalaenidae	M — S — A	sweet c
WESTERN CORN BORER	*Helotropha reniformis* Grt.	Lepidoptera Phalaenidae	M	sweet c
BERTHA ARMYWORM	*Mamestra configurata* Wlk.	Lepidoptera Phalaenidae	M — S	alfalfa, sweet c
ALFALFA CATERPILLAR	*Colias philodice eurytheme* Bdv.	Lepidoptera Pieridae	M — S — A	alfalfa
PEA WEEVIL	*Bruchus pisorum* (L.)	Coleoptera Bruchidae	M	peas
RED TURNIP BEETLE	*Entomoscelis americana* Brown	Coleoptera Chrysomelidae	M — S	rape, tu
POTATO FLEA BEETLE	*Epitrix cucumeris* (Harr.)	Coleoptera Chrysomelidae	M — S	potato, tomato
FLEA BEETLES	*Phyllotreta* spp.	Coleoptera Chrysomelidae	M — A	rape, sugar-b
SUNFLOWER BEETLE	*Zygogramma exclamationis* (F.)	Coleoptera Chrysomelidae	M — S	sunflow
ALFALFA WEEVIL	*Hypera postica* (Gyll.)	Coleoptera Curculionidae	S — A	alfalfa
ALFALFA CURCULIO	*Sitona scissifrons* Say	Coleoptera Curculionidae	S — A	alfalfa clover
WHITE GRUBS	*Phyllophaga* spp.	Coleoptera Scarabaeidae	M — S— A	lawn, p potato,
SPINACH CARRION BEETLE	*Silpha bituberosa* Lec.	Coleoptera Silphidae	A	potato, sugar-b
CLOVER SEED CHALCID	*Bruchophagus gibbus* (Boh.)	Hymenoptera Eurytomidae	M	alfalfa
SPINACH LEAF MINER	*Pegomya hyoscyami* (Panz.)	Diptera Muscidae	M — A	sugar-b
SUGAR-BEET ROOT MAGGOT	*Tetanops myopaeformis* (Roed.)	Diptera Ortalidae	M — A	sugar-b
WHEAT MIDGE	*Sitodiplosis mosellana* (Gehin)	Diptera Otonididae	M — A	wheat
SUNFLOWER MAGGOT	*Strauzia longipennis* (Wied.)	Diptera Tephritidae	M	sunflow

Note—The insects in this table are listed systematically according to order, then alphabetically according to family, then genus and th

ECONOMIC IMPORTANCE IN THE PRAIRIE PROVINCES

N k.,	PRINCIPAL FIELD CROPS ATTACKED	INJURIOUS STAGES OF INSECT	KIND OF INJURY	REMARKS	SUGGESTED CONTROL IF NECESSARY
	barley (apparently)	Adult nymph (larva)	Sap feeding, head attacked.	Kernels do not form.	No control recommended as yet.
	alfalfa	adult nymph	Sap feeding, buds injured.	Less abundant than alfalfa plant bug.	Burn over old alfalfa fields in early spring. DDT as spray or dust.
	alfalfa	adult nymph	Sap feeding.	Winters as egg.	Burn over old alfalfa fields in early spring. DDT as spray or dust.
	sunflower	adult nymph	Sap feeding.	Recent occurrence.	No control recommended as yet.
	alfalfa	adult nymph	Bud blasting.	Widespread.	Burn over old alfalfa fields in early spring. DDT as spray or dust.
	agropyrons, winter wheat	adult nymph	Sap feeding, stunts seedlings.	Injures plants.	No control recommended as yet.
	potato	adult nymph	Sap feeding.	Irregular occurrence.	Malathion, nicotine sulphate.
	bean, flax, pea, potato, sunflower	adult nymph	Sap feeding, vector of aster yellows.	Numerous hosts, widespread.	Control research in progress.
	alfalfa, fall rye, wheat	larva	Leaves eaten.	Hairy caterpillars.	No control usually needed.
	Canada thistle, sunflower	larva	Flowers and leaves eaten.	Migrates from south.	Beneficial when on Canada thistle.
	alfalfa, red clover, red fescue	larva	Leaves eaten	Larvae occur in late May. Adults emerge in June.	Aldrin, DDT.
	flax, mustard, wheat	larva	Leaves eaten.	Marching habit.	Aldrin, DDT.
	barley, grasses, rye, wheat	larva	Heads eaten.	Climbing habit.	Fall tillage of infested stubble. Spray or dust with DDT.
	flax	larva	Bolls hollowed.	Climbing habit.	Shallow fall tillage of infested fields.
	sweet corn	larva	Kernels at tip end of cob eaten.	It does not overwinter here.	Remove silks after pollination. Mineral oil treatment.
	sweet corn	larva	Tunnels in young stalk.	Occurs relatively early in season.	No control usually needed.
	alfalfa, flax, rape, sweet clover	larva	Heads and leaves eaten.	Less important than formerly.	DDT, fall tillage.
	alfalfa	larva	Foliage eaten.	Adults are yellow butterflies with wings bordered with black.	Control seldom needed.
	peas	adult larva	Seeds hollowed.	Does not overwinter here. May occur in purchased seed.	Sow uninfested seed.
	rape, turnip	adult larva	Leaves, flowers and seed pods eaten.	Overwinters as egg. Feeds on crucifers.	Plant on clean land, rotenone, DDT.
	potato, tomato	adult	Holes eaten in leaves.	Small black active beetles.	DDT, rotenone.
	rape, sugar-beet	adult	Leaves eaten.	Small very active jumping beetles.	DDT, rotenone.
	sunflower	adult larva	Leaves eaten.	Originally lived on native wild sunflower.	DDT, aldrin, toxaphene.
	alfalfa	adult larva	Plant tips and leaves eaten.	Recent arrival in extreme southern parts of provinces.	DDT, heptachlor, toxaphene.
	alfalfa clover	adult	Leaves eaten.	Adults eat notches in leaves.	Dieldrin, heptachlor, toxaphene.
	lawn, pasture, potato, strawberry	larva	Plant roots eaten.	Usually occur after breaking.	Small grains, clovers and alfalfa are little affected.
	potato, sugar-beet	larva	Leaves eaten.	Not widespread.	Control seldom needed.
	alfalfa	larva	Hollows seeds.	Seed pod perforated.	Sow clean uninfested seed.
	sugar-beet	larva	Larva tunnels into leaves forming a blotch.	Larvae may move from leaf to leaf.	No control usually needed.
	sugar-beet	larva	Destroys root of young plant.	Occurs in light soil.	Grow sugar-beets in heavier soil.
	wheat	larva	Feeds on kernels which shrink.	Larva may survive several years.	Control not necessary as yet.
	sunflower	larva	Tunnels in pith of sunflower stalk.	May weaken stalk.	Plant new crop as far as possible from last year's sunflowers.

enus and then species within each order.

BANDED SUNFLOWER MOTH[1]

A. Importance and Distribution

This native insect which was reported as injurious to sunflowers in Manitoba for the first time in 1944, has caused an average annual loss of approximately three per cent to the seed crop over a period of years. Its activity is confined to Manitoba where the sunflower seed crop was estimated at more than fifteen million pounds in 1955.

B. Plants Attacked and Kind of Injury

Wild sunflower was the original host, but with the appearance of large acreages of sunflower in Manitoba, this insect moved into that crop where the larvae feed upon and destroy the seeds.

C. Description, Life History and Habits

This is a small straw-colored moth with brown markings and a wing expanse of about one-half inch. The moths appear during July and August and are attracted to lights readily. Their tiny white, oval eggs are laid on the bracts of the sunflower heads shortly before the plants come into bloom. The larvae emerge about the time the florets open and feed upon pollen until they reach the third instar after which they penetrate the seeds, several of which may be destroyed by each larva during the feeding period which usually lasts until the middle of September. The larva gradually changes from white to pink to reddish and finally at maturity to green when at that time it is about five-eighths of an inch in length. Scores of larvae may occur in a single sunflower head. Each fully grown larva enters the soil to a depth of approximately two inches and spins a cocoon in which it spends the winter. Pupation takes place in late June and adult moths appear in July and August as stated previously. There is one generation each year.

FIGURE 23—Banded sunflower moth. Adults. Slightly more than twice natural size. —*Photo R. D. Bird.*

[1] *Phalonia hospes* (Wlshm.), Order Lepidoptera, Family Phaloniidae.

D. Control

Plowing down sunflower fields to a depth of five or six inches in the autumn will destroy a great percentage of the larvae which are thus buried so deeply that the moths cannot work their way to the surface the following year. Plant sunflowers as far as possible from fields which grew sunflowers the previous year. No insecticide is recommended at present largely due to the difficulty of applying it in fields of headed sunflowers. Parasites of the larvae are assisting in keeping this insect under control at the present time.

SUNFLOWER MOTH[1]

Importance and Distribution

The larvae of the sunflower moth, a native insect, destroy the seeds on the heads of cultivated sunflower in Manitoba, but the damage done by the insect at present is less than that done by the banded sunflower moth.

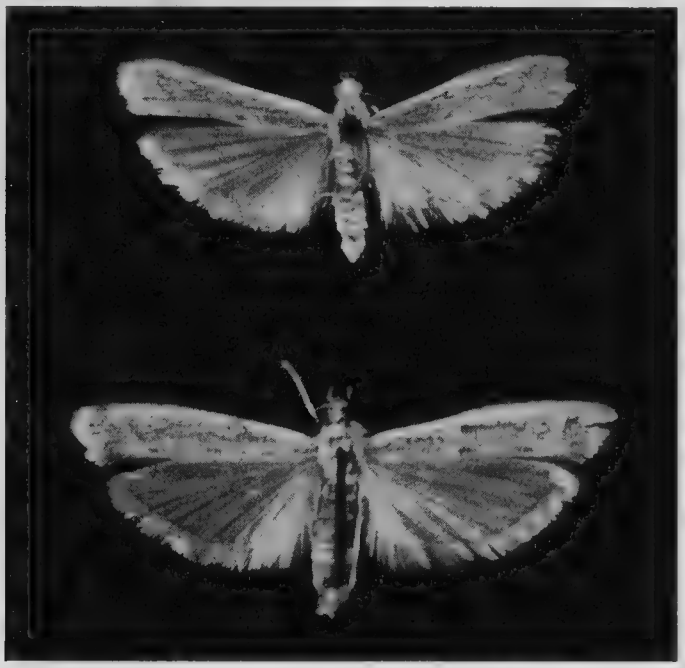

FIGURE 24—Sunflower moth. Adults. About three times natural size.
—*Photo R. D. Bird.*

[1] *Homoeosoma electellum* (Hulst), Order Lepidoptera, Family Phycitidae.

FIGURE 25—Sunflower moth. Larvae in sunflower head. About twice natural size.
—*Photo R. D. Bird.*

B. Plants Attacked and Kind of Injury

The original host was the native wild sunflower but the insect spread to the cultivated sunflower when it became a farm crop. The larvae attack the florets in the heads of the sunflower and later destroy the seeds. The injury is characterized by webbing and an accumulation of plant tissue and frass making the head appear untidy.

C. Description, Life History and Habits

The adult is a gray moth with a wing expanse of about three-quarters of an inch. The female moths lay their white eggs in the florets at the beginning of bloom. These eggs hatch in about one week into purplish or reddish-brown larvae with four light blue-green stripes extending the length of their backs. When fully grown, which requires about a month of feeding, they are about three-quarters of an inch long. They spend the winter as larvae or pupae within cocoons. There is one generation each year.

D. Control

Plant sunflowers as far as possible from fields which grew sunflowers the previous year. No insecticidal control is recommended at present. Parasites appear to be keeping this insect under control.

BEET WEBWORM[1]

A. Importance and Distribution

The damage caused by this introduced insect may be widespread one year and only of local importance the next year on the prairies. Although it attacks some field crops it creates more general concern in gardens and on weeds in grain fields and elsewhere. It is widely distributed over the agricultural areas of Manitoba, Saskatchewan and the south-eastern quarter of Alberta.

B. Plants Attacked and Kind of Injury

Sugar-beet, flax, field mustard, pea, corn, alfalfa, sweet clover and sunflower have each been attacked by the beet webworm among the field crops. Wheat, oat, rye and barley as well as grasses are practically ignored as food. Nearly all garden crops except potatoes and tomatoes may be injured seriously. Many weeds such as lamb's quarters, a

FIGURE 26—Beet webworm on sunflower. About twice natural size.
—*Photo R. H. Painter.*

[1] *Loxostege sticticalis* (L.), Order Lepidoptera, Family Pyraustidae.

preferred host, pigweed, Russian thistle and Canada thistle are much relished and where these are destroyed the insect is decidedly beneficial. Weeds in a field of grain may be attacked but even when they are consumed the larvae will not attack the grain and are likely to migrate from the field. The larvae have biting and chewing mouth parts and when they are numerous will completely strip the plants of their foliage. The leaves of small fruit trees have been eaten in prairie gardens.

C. Description, Life History and Habits

The adult beet webworm is a grayish-brown, mottled, winged moth about three-quarters of an inch long with a wing expanse of an inch to one and one-quarter inches. Swarms of moths appear from late May to early July with much variation in the time of appearance from year to year and from locality to locality. Groups of from two to four overlapping eggs about the size of a pin-head are laid on the undersides of the leaves or on the stems of their preferred hosts. These eggs hatch in about one week into tiny larvae which feed at first on the undersides, but soon eat through to the upper surfaces and skeletonize the leaves. The small larvae are green but soon turn darker, with a black stripe down the middle of the back and small black circular markings on each body segment. The larvae in summer reach maturity in about two weeks after which they enter the ground and form vertical cells which they line with silk. Pupation takes place in these cells with the pupal stage lasting from two to three weeks. A second period of adult emergence usually occurs during the last half of August and the larvae from these spend the winter in their upright silken-lined cells in the soil with pupation taking place in the spring. There are normally two generations each year. When short of food the larvae have a habit of migrating in a

FIGURE 27—Beet webworm larval or pupal cases. These cases are made in cells in the soil. About natural size.
—*Photo A. V. Mitchener.*

definite direction which may bring them to gardens or fields where palatable food abounds. When on a mass migration the larvae crawl over, rather than around upright objects including buildings. On account of these mass movements, beet webworm larvae are frequently mistaken for armyworms.

D. Control

When larvae of the beet webworm occur on weeds in wheat, barley, oat or rye fields no control is necessary as they will leave the fields without injuring the grain when the weeds have been eaten. When they occur in fields of sugar-beet, alfalfa, flax, sunflower, etc., and when they are migrating from weed patches towards favored hosts including vegetable crops, control may be necessary. Toxaphene and aldrin are the insecticides usually recommended and may be applied either as sprays or as dusts preferably while the larvae are small. Clean the tank of the weed sprayer thoroughly of all traces of any weed killer before using the sprayer to apply any insecticide. Keep weed patches which are favored by the moths for egg laying, under control as these may be focal points for the spread of the larvae. Trap furrows baited with the cutworm poisoned bait have been useful in stopping the progress of migrating larvae. Pyrethrum or derris should be used on plants to be used for human food. Franklin's gull and the crow eat great numbers of larvae at times.

EUROPEAN CORN BORER[1]

A. Importance and Distribution

This introduced insect is of considerable economic importance especially during some years in fields of sweet corn and field corn in Manitoba. At present it occurs in southern Manitoba where it was first recorded in 1948 and in south-eastern Saskatchewan where it was first observed in 1949. As yet it has not been reported from Alberta. Elsewhere in North America it has caused great losses as it spread west and then north into prairie Canada, since it was first found on the Atlantic coast in 1917.

B. Plants Attacked and Kind of Injury

Sweet corn, its favorite host, followed by field corn are injured most seriously. Elsewhere it has been found infesting more than 200 species of plants with stems large enough for the larvae to enter. The

[1] *Pyrausta nubilalis* (Hbn.), Order Lepidoptera, Family Pyraustidae.

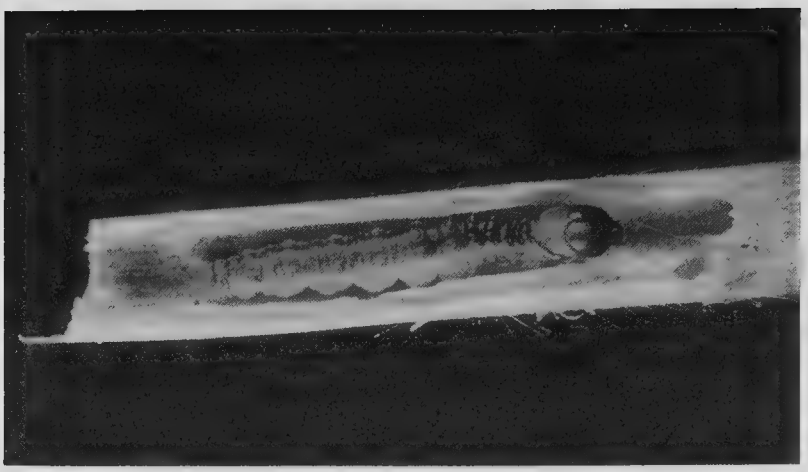

FIGURE 28—Larva of European corn borer in millet stem. About twice natural size.
—*Photo R. D. Bird.*

larvae eat their way into and weaken the corn stalks so that they may break. They also bore through the husks of the ears into the cobs and feed upon the soft developing kernels. Infested sweet corn cannot be marketed as table corn or as canning corn without sorting and removing the wormy ears. The small larvae eat holes in the leaves before they enter either the stalks or the cobs.

C. Description, Life History and Habits

The female moths are pale yellowish-brown with darker bands extending across the wings. The male moth is darker and smaller than the female and each night flier has a wing expanse of about one inch. The white and flat eggs, about half the size of a pin head, are laid in overlapping masses usually on the under sides of the leaves. The flesh colored larvae have dark brown or black heads and when fully grown are about an inch long, and are marked with somewhat inconspicuous dark brown spots. Pupae are brown in color. These insects winter over as mature larvae mainly in corn stalks or corn stubble. In early summer pupation takes place in the winter location and moths appear in early July. The eggs probably hatch in a week or less. The larvae mature in something less than a month and the pupal stage is probably completed in from one to two weeks although the duration of these stages has not been worked out here. The two brooded strain occurs in Manitoba or at least there is a partial second

generation. When weather conditions favor this insect as in 1949 and again in 1955 the partial second generation is especially destructive. It is known that mature larvae can survive our winters, but it is possible that a northward movement of adults in summer may be partially responsible for increased injury. When the young larvae first hatch they feed for a short time on the corn leaves where the eggs were laid and it is only during this first feeding period that the insect can be controlled with insecticides as it is impossible to reach the larvae after they have entered the stalks or the ears. After feeding a few days the larvae crawl along the leaves and bore into the stalks where they leave masses of frass at the points of entry. The tassel end of the stalk frequently breaks and falls over in a conspicuous way.

D. Control

As the European corn borer winters over only as larvae mainly in the stalks and stubble, the disposal of these by plowing them completely under, by burning them or by ensiling them is recommended. Use immune crops in the rotation. DDT and ryania are recommended to control the small larvae before they enter the stalks and the ears. Ryania is safe to use at any time but corn stalks and husks that have been treated with DDT should not be fed to animals. Ears from a field sprayed or dusted with DDT are protected by the husks and are safe to use as table or canned corn. The application of any insecticide must be made at the beginning of and during the period that the tiny larvae are feeding upon the leaves and will have to be repeated at weekly intervals as egg laying continues several weeks. It is important to be able to recognize all stages of this insect including the eggs and take prompt action if control is to be successful. Control measures are needed when as many as 20 to 30 egg masses occur on the leaves of 100 plants of sweet corn. Applications of a granular formulation of DDT have given good control.

COLEOPTERA

COLORADO POTATO BEETLE[1]

A. Importance and Distribution

The Colorado potato beetle, a native of North America, occurs throughout the agricultural area of Manitoba, that part of Saskatche-

[1]*Leptinotarsa decemlineata* (Say), Order Coleoptera, Family Chrysomelidae.

wan south of the north branch of the Saskatchewan River and in general the area of Alberta south of Edmonton. It was first recorded in Manitoba in 1884, in Saskatchewan in 1901 and in Alberta in 1899. It is an important pest of commercial acreages and garden patches of potatoes in many localities every year.

B. Plants Attacked and Kind of Injury

Although the potato is its most important host it also attacks tomato, egg plant, pepper, nicotine and native members of the night-

FIGURE 29—Colorado potato beetle larvae feeding on potato leaves. About natural size.
—*Photo R. D. Bird.*

shade family of plants. Both adults and larvae have biting and chewing mouth parts and consume great quantities of potato foliage and if not controlled, the potato plants may be killed and the yield of tubers greatly reduced.

C. Description, Life History and Habits

The adult beetle is convex above, and is about three-eighths of an inch long by one-quarter inch wide. Each wing cover bears ten longitudinal alternate black and yellow stripes. These insects overwinter in the adult stage only in the ground to a depth of up to one foot or more depending upon the texture of the soil. The adults emerge from the ground in early June about the time potato plants appear and after feeding and mating followed by a short preoviposition period, female beetles begin to lay clusters of orange-yellow eggs usually on the under sides of the terminal leaflets. Each female may lay several hundred eggs which hatch in about nine days into hump-backed larvae that soon begin to feed upon the potato foliage. These hardy, reddish larvae pass through four instars and become mature in about two weeks at which time they are about one-half inch long, with two rows of black spots on each side of their bodies. They then leave the plants, dig into the soil to a depth of about three inches, make a smooth walled cell and change into the pupal stage which lasts approximately seventeen days after which new adult beetles appear. In some years there is a single generation while in other years some of these adults produce a new generation of larvae which do not become adult beetles. The adults of the first generation enter the soil in late summer to hibernate. A heavy winter covering of snow makes the overwintering environment more favorable for the adults.

D. Control

Spray or dust potato foliage with DDT as soon as adult beetles are observed in early summer in areas where the Colorado potato beetle is not resistant to this insecticide. DDT will also control potato flea beetle and potato leafhopper. Where Colorado potato beetle has become resistant to DDT, a spray containing toxaphene, dieldrin, heptachlor or aldrin may be used to control this insect. A dust containing rotenone will also control Colorado potato beetle. Where Colorado potato beetle shows resistance to DDT and when potato flea beetle or potato leafhopper or both are present, toxaphene added to the DDT will give control of all three insects. If aphids appear later, use malathion in the spray. Nicotine sulphate will also control aphids.

SWEETCLOVER WEEVIL[1]

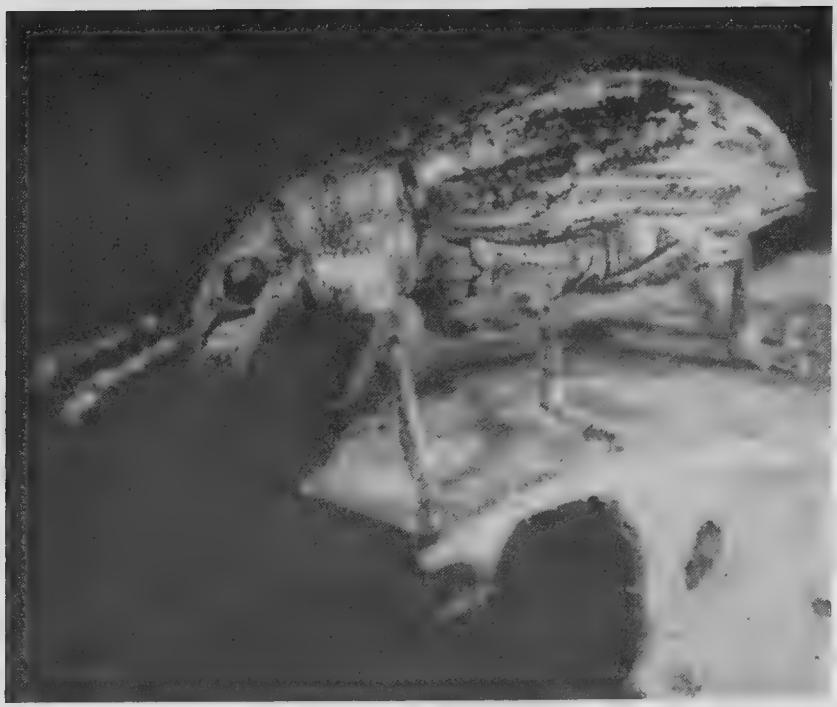

FIGURE 30—Adult sweetclover weevil showing leaf injury. About 17 times natural size. —*Photo R. D. Bird.*

A. Importance and Distribution

The sweetclover weevil is a major pest of sweet clover which is so widely grown in prairie Canada. This introduced insect, which is a native of Europe, was first recorded in eastern Manitoba in 1939 and quickly spread into Saskatchewan by 1940 and into Alberta by 1943. The adult beetles are especially destructive to seedling plants although the leaves of the second year's growth are also attacked. It is believed that the larvae which feed upon the rootlets of the second year's growth are responsible to some extent at least for the spread of root rot disease of sweet clover.

B. Plants Attacked and Kind of Injury

Sweet clover is the host of this insect almost exclusively although seedling alfalfa may be damaged if sweet clover is not available. Crescent-shaped notches are eaten from the margins of the sweet clover

[1]*Sitona cylindricollis* Fahr., Order Coleoptera, Family Curculionidae.

leaves. When seedling plants first emerge from the ground all the small leaves may be eaten in which case the plants die. Such poor stands of seedlings are often mistakenly attributed to poor germination. Farmers should be familiar with both the characteristic plant injury and the adult beetle itself which is responsible for this damage.

C. Description, Life History and Habits

The adult is a small dark-gray snout beetle about three-sixteenths of an inch long which feigns death when disturbed and is difficult to detect when lying motionless on the ground. The winter is passed only in the adult stage in trash, litter or top soil. The adults become active about the time second year sweet clover, upon which they feed, begins to become green. By flying or running, they seek new areas when sweet clover seedlings begin to appear above ground. The second year's growth of sweet clover grows rapidly and can stand considerable feeding without much damage, but seedling plants, when the few leaves are eaten, die quickly. The females drop their numerous very tiny, creamy-white, round, eggs, which turn dark in a few days, on the soil under second year's growth of sweet clover. Egg laying may continue from May to August after which the adults die. Upon hatching, which occurs in about two weeks, the small larvae enter the ground where they feed upon the root hairs and nodules of the sweet clover plants. Although they may be abundant they do not seem to retard the growth of the plant to any noticeable extent. The larvae which for the most part live in the top six inches of the soil take from five to nine weeks to mature. They then move up near the surface of the soil and pupate. In one or two weeks more the new generation adults appear and feed upon available sweet clover until the weather turns cold when they hibernate. There is one complete generation each year.

D. Control

Keep the yearly succession of sweet clover fields as far apart as possible bearing in mind the neighboring farms as well as the home farm. In areas where the sweetclover weevil is very destructive every year, discontinuing sowing sweet clover for two successive years should reduce the local population of weevils to a point where sweet clover can be grown again. The use of a fertilizer will result in more vigorous plants better able to resist the ravages of the weevils. As soon as the second year's crop of sweet clover has been harvested, the stubble should be plowed down or surface cultivated to destroy the beetles developing in the soil. Seedling sweet clover may be protected by spraying with dieldrin, heptachlor, toxaphene or DDT. Watch fields

newly sown to sweet clover as the plants come above ground and if leaf notching begins apply the spray to the plants and the ground. If a seedling crop of sweet clover is near a field of sweet clover that has been cut for hay watch the edge of this field for migrating adults and apply a spray along the edge of the field in a strip several rods wide if a migration is indicated.

WIREWORMS

A. Importance and Distribution

Wireworms are among the most injurious insects which attack field crops especially in Saskatchewan and Alberta, although they do a limited amount of damage in Manitoba. The prairie grain wireworm[1] is the most important and widely distributed species although the lesser grain and grass wireworm[2] also occurs in all three prairie provinces in destructive numbers. Other native species[3] have been found destroying vegetation from time to time in widely separated prairie areas. Additional species not listed have occurred in the area.

B. Plants Attacked and Kind of Injury

Wireworm larvae injure grains, grasses, legumes, corn, sunflower, flax, rape and potato as well as nearly all other cultivated plants including strawberry. Damage to plants is done mostly in early summer, an exception being to potatoes. Wireworms usually are most troublesome in loam soils, on land that has been summerfallowed and on land that has been in grass. They attack the seeds of grain shortly after they are planted, by eating out the starchy part of the seed and they also may destroy the embryo with the result that the plants do not appear above ground. A single wireworm may move along the drill row and destroy several young plants. Later wireworms bite into the central shoots or cut through the stems below ground

FIGURE 31—Click beetle. Adult stage of the wireworm. About four times natural size.
—*Photo R. D. Bird.*

[1] *Ctenicera aeripennis destructor* (Brown), Order Coleoptera, Family Elateridae.
[2] *Hypolithus bicolor* Esch., Order Coleoptera, Family Elateridae.
[3] *Aeolus mellillus* (Say), Order Coleoptera, Family Elateridae.
[3] *Ctenicera aeripennis aeripennis* (Kby.), Order Coleoptera, Family Elateridae.
[3] *Ctenicera morula* (Lec.), Order Coleoptera, Family Elateridae.
[3] *Limonius pectoralis* Lec., Order Coleoptera, Family Elateridae.

resulting in withering and the death of plants. The presence of wireworms is indicated by patchy stands of crops or the injury may be throughout the field. Wireworms never appear above ground. When the top soil heats up and dries out later in the summer, wireworms tend to go deeper into the ground where they are below the plants and therefore do less feeding.

C. Description, Life History and Habits

The adults of wireworms are called click beetles as when placed on their backs they can spring into the air to the accompaniment of a clicking sound and if lucky land on their feet. Dark colored adults, according to species vary from one-quarter to one-half inch or more in length. They have a short projection extending backward along the base of each outer wing at each side. Overwintered adults lay tiny white eggs in the soil during May, June or early July. These eggs hatch in about one month into very small wireworms which may take from five to ten or more years to reach full size of approximately one inch in length. These slender shiny wireworms are brownish-yellow in color and are tough in texture when squeezed between the thumb and finger. They have six legs located near the head end. The posterior segment of the larva varies in shape for each species and is useful for identification purposes. After passing the first winter, larvae may live for two years without food. Probably the length of time taken for the larvae to mature depends upon the available food

FIGURE 32—Wireworm larvae. About three times natural size.
—Photo R. D. Bird.

and upon soil conditions but regardless of the number of years taken to mature the larvae make cells in the top four inches of the soil in the month of July and pupate. The pupal stage is light in color and inactive. Adult beetles emerge within one month, but remain in the soil until the following season when the females lay their eggs. Due to this unusually long and varied life cycle a field may contain all sizes of larvae and at certain seasons different stages of the insect, but only the larvae are injurious to plants.

D. Control

Summerfallowing fields every two or three years where wireworms are doing damage will help to reduce their numbers. Summer fallows should be kept clean to starve newly hatched larvae. All crops should be sowed on well prepared soil. Fertilizers help to keep the crop vigorous. Wheat, spring rye, corn, potato and sunflower are more susceptible to larval injury than oat, barley, sweet clover and alfalfa. Seed treatments with aldrin, dieldrin, heptachlor or lindane are recommended. The respective manufacturer's directions should be followed carefully. All seeds must be coated with the insecticide and no left-over treated seed should be fed to farm animals. It must always be remembered that insecticides are poisonous. These insecticides and also chlordane are recommended for soil treatments where an especially valuable crop is to be grown. Combination dressings for the control of wireworms and some seed-borne diseases are also available. The soil treatment can reduce wireworm populations quickly. The use of lindane may result in tainting root crops after soil treatment for two or three years.

BLISTER BEETLES

A. Importance and Distribution

The caragana blister beetle[1], the ash-gray blister beetle[2] and Nuttall blister beetle[3] are three common native prairie species of blister beetles. These and the adults of other species feed upon the foliage of many plants, but although widely distributed, seldom occur in sufficient numbers to be very destructive except locally. Their bodies contain a substance called cantharadin which when applied to the skin may cause a blister to form and because of this they are called blister beetles. The larvae of the first two species mentioned are beneficial as they live upon grasshopper eggs.

[1] *Epicauta subglabra* (Fall), Order Coleoptera, Family Meloidae.
[2] *Epicauta fabricii* (Lec.), Order Coleoptera, Family Meloidae.
[3] *Lytta nuttallii* Say, Order Coleoptera, Family Meloidae.

B. Plants Attacked and Kind of Injury

The caragana blister beetle adult feeds largely on the leaves of caragana which is grown widely for windbreaks in fields near roadsides, while the ash-gray blister beetle feeds upon alfalfa, broad bean and potato. Nuttall blister beetle attacks broad bean, caragana, pea, potato and rape. The adults have biting and chewing mouth parts and a swarm of feeding beetles can do much damage to a localized area in a relatively short time. The larvae do not feed upon vegetation. As the larvae of some species feed upon the eggs of our injurious grasshoppers, in general blister beetles are considered to be more beneficial than harmful to agriculture.

FIGURE 33—A blister beetle. About three times natural size.
—*Photo R. D. Bird.*

C. Description, Life History and Habits

Blister beetles unlike many other beetles have front wings which are flexible and leathery in texture. These beetles are narrowed behind the head and thus appear to have a short neck. Usually they are about four times as long as they are wide. The caragana blister beetle is shiny black, the ash-gray blister beetle's name indicates its color and Nuttall blister beetle is iridescent. Each of the first two species is about one-half inch long, more or less, while the latter is larger. Blister beetles in general have unusual life histories as there are several successive distinct forms or stages to the larvae which live in the ground in grasshopper egg pods. These different larval forms are in addition to the adult, egg and pupal stages. The life history of Nuttall blister beetle is unknown. Blister beetles occur most commonly during the latter years of a grasshopper outbreak.

D. Control

DDT, chlordane or aldrin is recommended when blister beetles appear suddenly in numbers sufficient to warrant control. These

insecticides are not recommended on vegetables with edible tops or on a hay crop. Rotenone or pyrethrum is recommended on such plants. Any one of the insecticides mentioned may be used either as a spray or a dust. Prompt action only will control these insects which usually appear suddenly and consume plant foliage quickly.

HYMENOPTERA

WHEAT STEM SAWFLY[1]

A. Importance and Distribution

The wheat stem sawfly is a native insect of major importance to the wheat grower in Western Canada. Originally it developed within the hollow stems of our native grasses and was first recorded here in 1895. After that it spread into wheat fields over millions of acres of crop land. In Manitoba it occurs south of the Riding Mountain as far east as Gladstone and Portage la Prairie and in Saskatchewan and in Alberta south of the north branch of the Saskatchewan River. During the past decade or more, it has decreased in importance in Manitoba.

FIGURE 34—Wheat stem sawfly. Adult female. About four times natural size.
—*Photo R. D. Bird.*

B. Plants Attacked and Kind of Injury

Spring wheat, including durum wheat to a lesser extent, and spring rye are the most susceptible crops. Brome grass is a host, but the larvae seldom mature in it although parasites develop there. Other farm crops may be considered immune from injury. The damage done to wheat and rye is caused by the larvae cutting the stems near ground level which so weakens them that they

[1]*Cephus cinctus* Nort., Order Hymenoptera, Family Cephidae.

break readily at that point by wind or rain storm and fall, and consequently harvesting these stems is difficult or impossible. The feeding of the larvae within the stems may have a slight effect on the quality of grain produced but grain from heads grown on infested stems proved to be as plump and bright as that from heads on uninfested stems according to samples examined in Manitoba.

C. Description, Life History and Habits

The adult wheat stem sawfly is a four-winged, shiny-black insect approximately one-half inch long with three prominent yellow bands around the abdomen. The legs of the female are bright yellow except for the parts next to the body and entirely yellow in the male which is slightly smaller than the female. The female may also be distinguished from the male as it has a visible, short saw-like ovipositor by means of which it inserts its eggs within the plant stems. The eggs are somewhat peanut-shaped, light in color and about one twenty-fifth of an inch long and may be found attached to the inside wall of the hollow stem. The larvae, which when fully grown are about one-half inch long, are legless, yellowish-white and have dark, chewing mouth parts and short brown pointed posterior ends.

FIGURE 35—Wheat stems broken and lying on the ground as a result of wheat stem sawfly infestation.

—Photo A. V. Mitchener.

FIGURE 36—Wheat stem sawfly infested wheat stubs showing where they were cut off by the larvae before they withdrew into the hollow stubs. Less than natural size.

—Photo A. V. Mitchener.

Adults, with the females vastly outnumbering the males, appear in the fields from the second week in June to the second week in July. The female sawfly clings to the plant stem, head downward with wings held closely together when ovipositing or resting. Each female is capable of laying from 40 to 50 eggs which are laid one at a time over a period of days any distance above the fourth node from the top of the stem. The eggs hatch in approximately one week. During the egg laying period several eggs may be found within a stem and also one or more larvae. Later, however, only one larva survives within any stem as cannibalism prevails. The surviving larva feeds on the soft part of the inside wall of the stem and eats its way through all the nodes of the stem as the plant matures. Just before the stem ripens the larva reaches full size and instinctively retreats to the bottom of the stem where it cuts a circular groove in the stem wall about ground level thus preparing for the stem to break off so that the adult sawfly will be able to escape the following year. It withdraws into that part of the stem below ground plugs the top of the stub, makes a long parchment-like waterproof cocoon and there head up passes the winter. In late May pupation takes place and the adults which do not require any food appear in June and early July as stated previously. The adults are active only on warm sunny days. Dry weather favors these insects. Although the adults are not strong fliers they can migrate from infested stubble to a new crop location readily. There is one generation per year. A farmer can decide if his wheat field is infested

by collecting several dozen headed stems at random from several areas in the field and splitting them open lengthwise through the nodes. If the nodes are hollow instead of solid and if a fine dust-like material is found in the hollow of the stem, then that stem is infested.

D. Control

Any control program in wheat stem sawfly infested territory should be undertaken by all farmers as a community project even though individual farmers can by their own efforts reduce the damage on their own farms. Immune crops may be substituted for wheat or spring rye. Wheat or spring rye should not be grown in a field which was infested the previous year. Infested stubble should be shallow cultivated preferably as soon after harvest as possible or at latest in spring to expose the larvae so that they will dry up and die. Deep plowing and packing the soil delays the seasonal emergence of the adults, but may not prevent many from emerging. Wheat or spring rye sown on summerfallow, or on land which grew an immune crop the previous year, should not be heavily infested except possibly near the edges of the field, unless adults emerge from infested nearby

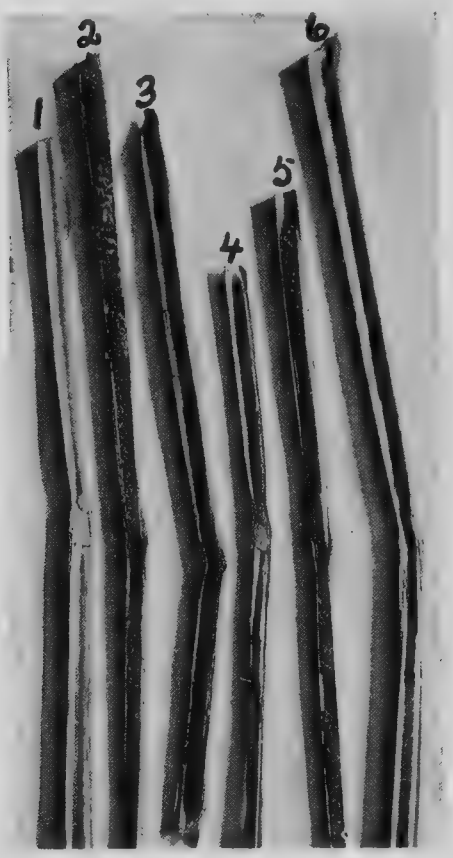

FIGURE 37—Wheat stem sawfly. Stems No. 1 and 4 are not infested. Others show hollow nodes or frass due to sawfly infestation.

—Photo A. V. Mitchener.

stubble. Sow susceptible crops as far as possible from fields that were infested the previous year. Delaying seeding until after May 15 where wheat stem sawfly is serious will reduce infestation. Grow relatively immune wheat such as Chinook and Rescue where these are recommended.

A temporary trap crop of a strip of susceptible wheat or spring rye fifteen to twenty feet wide, sowed around the field to be protected, about ten days or two weeks before planting the main crop, will attract the females for egg laying as they attempt to move into the new crop from an outside infested area. Such a trap crop will be improved if a bare cultivated strip ten or twenty feet wide is left between the trap crop and the main crop. The adults do not like to fly over the bare ground and they congregate in the trap crop where many eggs will be laid in the hollows of the stems. This trap crop should be cut for hay during the third week of July, or as soon as the adult sawflies disappear, while the trap crop is still very green, and before the larvae retire into the bases of the stems. A permanent trap crop of brome grass, which the sawflies accept readily for oviposition, may be planted on roadsides and around fields. Although adult sawflies lay their eggs very freely in the flowering stems of brome grass, very few larvae mature and therefore this crop helps to control them. The use of a fertilizer will assist the crop in withstanding wheat stem sawfly attack. Infested fields should be harvested slightly on the green side before the stems break and fall. Stubble burning is useless as the larvae are underground and are not affected by the heat.

DIPTERA

WHEAT STEM MAGGOT[1]

A. Importance and Distribution

This is a native species of insect whose conspicuous effects often indicate more damage than actually occurs. It is one of our minor field crop insects widely distributed in Manitoba and Saskatchewan and in Alberta in the area south of Calgary.

B. Plants Attacked and Kind of Injury

Wheat is most affected although it has been found infesting barley. Typical injury to crested wheat grass, western rye grass and meadow fescue indicates that they are attacked although it is probable that the larvae do not mature in these plants. No doubt it occurs on wild and

[1] *Meromyza americana* Fitch, Order Diptera, Family Chloropidae.

FIGURE 38—Wheat crop infested with wheat stem maggot. White heads on shorter stems show infested stalks.

—Photo A. V. Mitchener.

other cultivated members of the grass family. The infestation is indicated by random heads ripening prematurely throughout the field. Stems bearing these heads are usually shorter than normal and are recognized easily after the crop is in head, just before it begins to ripen. The larva severs the stem just above the top node and the head, including the stem above the top joint, ripens prematurely, while the remainder of the stem, including the leaves, remains as green as the uninfested plants in the field. The straw-colored head and top part of the stem may be pullled out easily from the remainder of the plant stem. Infested stems remain erect and do not fall over like stems infested with wheat stem sawfly or hessian fly. As the stem is severed before the wheat head comes into bloom, no kernels develop in the head. Infestation varies from a trace up to 20 per cent occasionally. Damage varies from year to year, from field to field and among wheat varieties.

C. Description, Life History and Habits

The adult green-tinged, two-winged fly is about one-fifth of an inch long, with three longitudinal black stripes on the thorax and abdomen and has green eyes. Adults appear in the field around the middle of June after which the females lay small snow-white eggs, singly, on the leaves of the host plants. Most of these eggs have

been found on leaves near the ground. The eggs hatch in approximately one week into slender, headless, footless greenish larvae. Those occurring highest on the plants, it is believed, move between the leaf sheaths and the stems down to a point just above the top joints where they feed upon the soft plant tissue. The larvae reach maturity in about three weeks during which time they have severed the stems. Each larva then moves upward between the leaf sheath and the dead stem to a point about one to one and one-half inches below the junction of the leaf blade and the stem and forms a pale-green flattened puparium. The pupal stage which includes the prepupal form lasts about seventeen or eighteen days in summer. Most of the adults of this generation emerge during the first half of August. The life history for the remainder of the summer has not been determined for western Canada, but elsewhere this generation of adults lays its eggs on grasses and volunteer grains. These eggs hatch in due course and it is believed that the winter is passed among these plants in the larval stage. Pupation takes place in early summer the next year and the adults appear as stated previously in June. There are two generations each year.

D. Control

Sow wheat as early as possible as there is some evidence that early sown grain is less infested than that sown later. Use a variety of wheat, suitable for the district, which is attacked least. Practise crop rotation as field crops other than wheat and barley are not infested. Destruction of volunteer grain and grasses is also recommended.

HESSIAN FLY[1]

A. Importance and Distribution

Although the hessian fly, which was introduced from Europe into North America around 1776, is not one of our ten major field crop insects, it occurs locally in all three provinces from time to time. It was first reported from Manitoba in 1899 in spring wheat and reached the southwest corner of Alberta by 1916 where fall wheat was grown at that time. In 1938 it was found in spring wheat in central Alberta. In Manitoba it occurs south of the Riding Mountains eastward beyond the Red River and in the southern parts of Saskatchewan and Alberta. Frequently hessian fly injury is confused with hail damage and therefore is not recognized by the farmer.

[1] *Phytophaga destructor* (Say) Order Diptera, Family Itonididae.

B. Plants Attacked and Kind of Injury

Wheat, barley and rye are the principal hosts of the hessian fly in the order named. Oat and other farm crops are not attacked. The central part of the young plant is attacked in the early growing season, but even though this part of the plant may die, the plant may stool out. Little damage has been reported from the effects of this early season infestation. The adults from this generation lay their eggs on the leaves of heading plants. Larvae move to the plant stem and feed upon the plant sap and so weaken the stem at the point of attack that it bends over, giving the crop the appearance of having been struck by a hail storm. The tops of the stems may bend upward again and grow. The grade of wheat on infested plants may be impaired even though the yield may not be lowered to any marked extent if the heads can be harvested.

FIGURE 39—Hessian fly. Pupal or flaxseed stage on wheat. · About three times natural size.
—Photo Dominion Department of Agriculture.

C. Description, Life History and Habits

The adult hessian fly is a tiny, delicate, dark two-winged insect about one-eighth inch long, which is seldom if ever noticed in the field. The female which is slightly larger than the male has an orange-red abdomen while that of the male is dark in color. The very small eggs are orange-red in color. At first the reddish larvae are active but presently become stationary when

their later greenish-white color makes them difficult to see. After feeding upon plant sap to maturity they form dark brown puparia on the surface of the plant stem or near the base of the plant. The insect winters over in the puparium and the adult flies, which normally do not feed, appear during the last half of May when the females begin laying their numerous eggs almost at once in the grooves of the upper surfaces of the leaves. The eggs hatch in about ten days and the young larvae work their way towards the bases of the plants where they feed on the plant sap. The larvae mature in approximately two weeks and form puparia. A portion of these puparia produce adult flies in late June and a partial second generation follows. Under very favorable weather conditions enough flies may emerge to cause noticeable damage. The adults of this partial second generation lay their eggs usually above the second joint on the plant. The presence of brown pupae often embedded on the surface of the stems will indicate the location of the insect. Puparia from this partial second generation as well as the puparia from the first generation which did not produce adults, spend the winter in that stage and those that survive produce adults the following May at the same period of emergence. It will be observed that the puparia from the first generation are at the bases of the plants while those from the partial second generation will be in the straw, or if knocked off, may be in screenings.

D. Control

The usual farm practices combined with prairie climatic conditions seem to keep this insect from becoming a pest of much economic importance. Elsewhere in North America, especially where fall wheat is grown and where the rainfall is greater, this insect is of great economic importance. If the hessian fly should become a pest locally at any time, replace wheat and barley with immune crops. The adult flies are so fragile that they are unlikely to fly very far from an infested field, although they may be carried by the wind. Burning stubble in autumn will kill the pupae above the surface of the ground. Plowing in autumn or before May 1 will bury the pupae which occur at the bases of the host plants. Feeding or destroying screenings or tailings which contain pupae may be advisable. Use oat or flax as a nurse crop for legumes or grasses or any combination of them rather than wheat or barley so that wheat stubble may be burned without harming the seedlings if hessian fly should become a problem.

INSECT POLLINATORS

General

All prairie farm crops including fruits and vegetables are grown from seeds. Seeds are produced when pollen from the male part of the flower (anther) is transferred to the female part of the flower (stigma) of any farm crop. This transfer of pollen is called pollination. The flowers of some farm crops such as barley, oat, pea and wheat are self-fertile and are self-pollinated. Rye which is self-fertile is pollinated by the wind. Corn is also pollinated by the wind or by gravity. Brome grass, crested wheat grass, meadow fescue and tall wheat grass are each cross-pollinated by the wind. However, a great many of our plants depend upon insects to carry pollen from flower to flower. Crops such as alfalfa, alsike, red clover and sweet clover are mostly self-sterile and must be cross-pollinated for a good set of seed and some insects accomplish this effectively. Buckwheat, flax, rape and sunflower are other prairie crops which benefit by insect visitations. Fruits such as apple, currant, gooseberry, plum, raspberry and strawberry are benefitted also by the visitations of insects for fruit setting. Cantaloup, cucumber, pumpkin, squash and watermelon are vine fruits which require insect pollinators as the male and female flowers occur on different parts of the same plant. Cross-pollination not only is necessary for many plants but also when it occurs in others it results in more vigorous seedlings.

Most of our native prairie insect pollinators, which belong largely to the order Hymenoptera, nested originally in the soil which for centuries had remained almost undisturbed, or in decaying wood. This environment across the prairies has been changed with the advent of the farmer and is still undergoing change as crop specialization progresses. The original nesting places of the native pollinators are becoming decreasingly available while now vast acreages of flowering farm crops need a much greater population of pollinating insects. All native bees, except bumble bees which store some nectar and pollen, are solitary and live on the food that they obtain from day to day from the flowers. There must therefore be a succession of bloom during the summer while the adults are active if they are to thrive or even survive. With the change from the former prairie environment to the present farming practices, many native insects instead of increasing have declined in numbers. The result is that now it is difficult to get satisfactory sets of seed on some crops due to the relative scarcity of the necessary wild pollinators. Fortunately semi-

domesticated honey bees, which are well fitted for this work and widely available, may take the place of the wild bees on many crops.

HONEY BEE[1]

Honey bees are now kept throughout the prairie provinces almost entirely for the honey crop with the production of beeswax of secondary importance. The time is at hand when proper recognition should be given to their importance as pollinators of specific farm seed crops and fruits in Prairie Canada. In the southern United States and in California package honey bees and also queens are raised in great numbers for sale and it is from these areas that prairie apiarists obtain most of their honey bees each spring since most beekeepers do not overwinter their colonies. Formerly many beekeepers owned only a few colonies. The tendency now is towards fewer beekeepers with larger commercial apiaries where hundreds of colonies are distributed among various sites by a single owner who depends upon these honey bees largely if not entirely for his livelihood. In Prairie Canada there are numerous apiarists who own 500 or more colonies and some have as many as 1000 colonies.

Worker honey bees are well adapted for gathering both nectar and pollen. By means of their specialized tongues which they insert into the flowers they draw minute quantities of nectar through their mouths into their honey stomachs where it is carried back to the hive and transferred to house honey bees which place it in the honeycomb where it is finally changed into honey. The body of each honey bee is clothed with many branched hairs admirably adapted for catching pollen grains as the insect walks over the ripe anthers of the flower. Some of this pollen is rubbed off on the stigmas of other similar flowers as the worker moves from flower to flower. The honey bee's legs are used for moving the remaining adhering pollen grains from its body hairs into a specialized area known as a pollen basket, located on the outside of each hind leg where it is carried back to the hive for other worker honey bees to pack in the cells of the honeycomb. Honey bees must have a daily available supply of both honey and pollen throughout the year when for most of the time food supplies are not available in the fields. When these food supplies are available in the flowers they gather these stores beyond their immediate needs. Very strong colonies may store several hundred pounds of honey in addition to their summer requirements and may gather as much as 75 pounds of pollen each year. Not only are honey bees well adapted

1*Apis mellifera* L., Order Hymenoptera, Family Apidae.

FIGURE 40—Worker honey bee visiting clover. About three times natural size.
—*Photo Dept. Pub. Relations, O.A.C., Guelph.*

for distributing pollen but also as they are semi-domesticated they may be moved readily from location to location and their numbers in any locality increased at will. A strong colony in midsummer may have a population of 75,000 workers, most of which during their lives will visit flowers. Large acreages of crops needing pollination may be serviced where native bees are too scarce to accomplish this effectively.

The nectar secreted by different species of plants varies in its sugar content. Furthermore, this sugar content varies inversely with the relative humidity of the surrounding atmosphere. In general honey bees prefer to work on plants which produce the sweetest nectar. Many plants bear flowers which produce both nectar and pollen and honey bees may gather both products on a single field trip. They confine their activities on any one trip largely to a single species of

plant which greatly aids in effective pollination. Moreover, individual honey bees visit flowers in a definitely limited area of the field on successive trips each day until that source of food becomes less attractive than some other source to be found elsewhere.

Seed growers and others who wish to use honey bees as pollinators should get in touch with some professional beekeeper well in advance of the time that the pollinating services are needed. It is not advisable for a seed grower to try to provide his own honey bees. Professional beekeeping is a specialized occupation requiring much knowledge and skill. Any farmer, however, can learn the rudiments of beekeeping and keep a few colonies for pollination in orchard and garden as well as for a family supply of honey. Our improved highways now permit a seed grower to interest a beekeeper many miles distant, as colonies can be transported easily by truck. Colonies of honey bees should be placed in groups throughout the field if possible but where this is not possible they should be placed on the leeward side of the field as it has been found that honey bees when carrying loads prefer to fly with the wind rather than against it.

At least two or three colonies per acre are recommended for seed production for alsike, red clover and sweet clover. Although some native bees are much better pollinators of alfalfa than honey bees, there are areas in North America where honey bees are used extensively as pollinators of alfalfa. For this crop as many colonies as possible per acre should be used. In the prairie provinces honey bees visit alfalfa readily for nectar but not for pollen. In obtaining nectar they trip very few flowers and consequently are poor pollinators of this crop as they do not come in contact with the pollen. Probably two colonies per acre should be used in sunflower fields. For pollination purposes only strong colonies headed by good queens with many frames of eggs and developing brood should be used as pollen for brood rearing is needed and such hive conditions stimulate flower visitation. Colonies should be brought to the fields at the beginning of the blooming period. Flowers which compete with the crop needing pollination should be as scarce as possible in the vicinity. For example if sweet clover, which is very attractive, grows within a flying distance of even two miles, honey bees may not pollinate some crops effectively as they will be attracted probably to the sweet clover. Seed crops should be isolated from other flowering crops or plants which bloom at the same time as far as possible. Sowthistle bloom may be quite attractive to honey bees.

Seed growers should be prepared to pay the beekeeper for pollination services as usually it will not pay the beekeeper to move his

colonies for the nectar he will get, especially when more colonies are needed per acre for pollination than he would normally place in the field for nectar alone. Payment for the use of honey bees may be on the basis of a stated sum per colony or on the basis of a percentage of the seed crop or a definite amount per colony and a smaller percentage of the seed crop. A written agreement drawn up in duplicate and signed by both parties is highly recommended to avoid possible later disagreements.

BUMBLE BEES[1]

Many species of bumble bees are important pollinators of legumes and other plants. Unlike honey bees only the mated queen bumble bees survive our winters and they do this in hibernation protected among moss or leaves or in the ground, it is believed. About the time fruit bloom first appears, the queens of some species are on the wing searching for nesting sites and food. A queen frequently selects a mouse nest or a bird's nest on the ground for a summer home. After selecting a place for a home, she prepares a bed of woolly material, makes some wax cells, collects and stores pollen and nectar and lays a few eggs which develop into worker bumble bees. These workers take over the field and home duties and the queen confines her activities largely to further egg laying to increase the worker force. In the field the workers visit the flowers of many kinds of cultivated and native plants and are useful pollinators as they, like honey bees, are well adapted for transferring and gathering pollen. Bumble bees are valuable in proportion to their numbers in any locality for pollinating alfalfa, cucurbits, fruits, red clover, sunflowers and other plants. One of our most important pollinators of alfalfa is the alfalfa bumble bee, *Bombus terricola* Kby. Bumble bee populations fluctuate from year to year due probably to the presence or absence of a steady food supply and to weather conditions. They work at lower temperatures than leafcutting bees.

LEAFCUTTING BEES[2]

The leafcutting bees are especially valuable for pollinating alfalfa. They get their name from their habit of cutting pieces from rose and

[1] *Bombus borealis* Kby., Order Hymenoptera, Family Apidae.
[1] *Bombus fervidus* (F.), Order Hymenoptera, Family Apidae.
[1] *Bombus frigidus* Cress., Order Hymenoptera, Family Apidae.
[1] *Bombus rufocinctus* Cress., Order Hymenoptera, Family Apidae.
[1] *Bombus sylvicola* Kby., Order Hymenoptera, Family Apidae.
[1] *Bombus ternarius* Say, Order Hymenoptera, Family Apidae.
[1] *Bombus terricola* Kby., Order Hymenoptera, Family Apidae.
[2] *Megachile brevis* Say, Order Hymenoptera, Family Megachilidae.
[2] *Megachile dentitarsus* Sladen, Order Hymenoptera, Family Megachilidae.
[2] *Megachile frigida* Sm., Order Hymenoptera, Family Megachilidae.
[2] *Megachile inermis* Prov., Order Hymenoptera, Family Megachilidae.
[2] *Megachile latimanus* Say, Order Hymenoptera, Family Megachilidae.
[2] *Megachile melanophaea* Sm., Order Hymenoptera, Family Megachilidae.
[2] *Megachile relativa* Cress., Order Hymenoptera, Family Megachilidae.

other leaves with which they line their brood cells. These cells are made in beetle burrows in decaying wood, in hollow plant stems and elsewhere or by some species in the soil. Each brood cell is provisioned with pollen and nectar, an egg is deposited and the cell is then sealed with pieces of leaves. Several cells may be placed end to end in a single tunnel. The insects have pollen brushes on the undersides of their bodies but have no pollen baskets on their hind legs. The hairs of the pollen brush collect pollen grains in countless numbers which may be seen easily when a specimen is caught. The most important species visiting alfalfa seems to be *Megachile frigida* Sm. Leafcutting bees are most abundant in fields of alfalfa surrounded by wooded areas which provide nesting sites in decaying logs but these areas do not occur frequently on the older cultivated farms of the prairie provinces. It is possible that some way may be found to increase the numbers of native bees but the farmer who produces various crops which are insect pollinated should look to the greater use of honey bees whose numbers can be increased as required and that quickly when and where their services are needed.

USE INSECTICIDES WITH CARE

Insecticides used to control injurious insects attacking our field crops should not be applied when the crop is in bloom as many of the beneficial insects may be killed. Insecticides should be applied before the flowers open when these beneficial visitors are not present. If insecticides for any unavoidable reason must be applied during the time the crop is in bloom, they should be applied in the late evening, at night or during the early morning when beneficial insects are not flying in the field. At such times especially, an effective insecticide that is least harmful to pollinating insects should be selected for use. Toxaphene, if recommended for the particular insect pest, seems to be one of the safest to use at this time. When any insecticide is to be used on a crop that is likely to be visited by honey bees shortly after the application, the farmer should notify any beekeeper whose honey bees are within a few miles of his field. Any such beekeeper may then move his apiary away from possible danger if he wishes to do so. Sprays or dusts should be applied when the air is still and these should not be allowed to drift on other flowering plants which are being visited by honey bees or other pollinating insects. Mutual good-will between farmers and beekeepers should be wide-spread on the prairies.

FIELD CROPS AND THEIR INSECT ENEMIES

KEY TO TYPES OF INSECT INJURY

(A) Conspicuous insects which eat pieces from the leaves of various field crops.

(B) Insects which occur on the surface of the plants and suck the sap from the leaves or stems without any visible hole, and cause wilting or stem breakage and possible death of the plants.

(C) Insects that chew and cut off the underground stems or otherwise injure parts of plants underground.

(D) Insects that sever or work in the stems of barley, grasses, rye, sunflower and wheat almost exclusively.

(E) Insects that damage the heads or seeds of various crops.

(F) Insects that confine their injury to corn.

CROPS AND INSECTS

Alfalfa	(A) alfalfa caterpillar, alfalfa curculio, alfalfa weevil, beet webworm, bertha armyworm, black armyworm, blister beetles, tiger moth larva. (B) alfalfa plant bug, aphids, a plant bug, lygus bugs, rapid plant bug, superb plant bug. (C) cutworms. (E) clover seed chalcid, Say stink bug.
Barley	(A) armyworm, grasshoppers. (B) aphids, hessian fly. (C) pale western cutworm, red-backed cutworm, western chinch bug, wireworms. (D) wheat stem maggot. (E) grass thrips, Say stink bug, wheat head armyworm.
Bean	(A) blister beetles. (B) Say stink bug, six-spotted leafhopper.
Brome Grass	(A) armyworm. (C) western chinch bug. (D) wheat stem sawfly.
Corn	(A) armyworm, beet webworm. (B) corn leaf aphid. (C) cutworms, wireworms. (F) corn earworm, European corn borer, western corn borer.
Flax	(A) army cutworm, beet webworm, bertha armyworm, field cricket. (B) Say stink bug, six-spotted leafhopper. (C) pale western cutworm, red-backed cutworm, wireworms. (E) flax bollworm.

Grasses	(A) armyworm, black armyworm. (B) Say stink bug. (C) white grubs, wireworms. (D) wheat stem maggot. (E) wheat head armyworm.
Mustard	(A) army cutworm, beet webworm.
Oat	(A) armyworm, field cricket, grasshoppers. (B) aphids, Say stink bug. (C) pale western cutworm, red-backed cutworm, wireworms.
Pea	(A) beet webworm, blister beetles. (B) aphids, Say stink bug, six-spotted leafhopper. (E) pea weevil.
Potato	(A) blister beetles, Colorado potato beetle, potato flea beetle, spinach carrion beetle. (B) aphids, potato leafhopper, six-spotted leafhopper. (C) white grubs, wireworms.
Rape	(A) blister beetles, bertha armyworm, flea beetles, red turnip beetle. (C) wireworms.
Red Clover	(A) black armyworm.
Rye	(A) armyworm, field cricket, grasshoppers, tiger moth larva. (B) Say stink bug, hessian fly. (C) red-backed cutworm, wireworms. (D) wheat stem sawfly. (E) wheat head armyworm.
Sugar-Beet	(A) beet webworm, flea beetles, spinach carrion beetle. Larvae of spinach leaf miner form blotches in sugar beet leaves. (B) aphids. (C) red-backed cutworm, sugar-beet root aphid.
Sunflower	(A) beet webworm, painted-lady larva, sunflower beetle. (B) ragweed plant bug, Say stink bug, six-spotted leafhopper. (C) red-backed cutworm, wireworms. (D) sunflower maggot. (E) banded sunflower moth, sunflower moth.
Sweet Clover	(A) beet webworm, bertha armyworm, sweetclover weevil. (C) red-backed cutworm.
Turnip	(A) red turnip beetle.
Wheat	(A) army cutworm, armyworm, field cricket, grasshoppers, tiger moth larva. (B) aphids, hessian fly, Say stink bug, western wheat aphid. (C) pale western cutworm, red-backed cutworm, western chinch bug, wireworms. (D) wheat stem maggot, wheat stem sawfly. (E) wheat head armyworm, wheat midge.

GLOSSARY

ABDOMEN. The third of the three body divisions of an insect.

ACTUAL ALDRIN. The specified amount of aldrin by weight contained in a given volume of commercial aldrin preparation. This definition is also applicable to other insecticides.

ADULT. The full grown stage when an insect is sexually mature.

ANTENNA (pl. antennae). Two sensory jointed feelers located on the head of an insect.

ANTHER. The pollen bearing part of the flower.

BACTERIAL DISEASE. A disease caused by a unicellular microscopic organism.

CATERPILLAR. Usually the larva of certain Lepidoptera.

CELL. An area in the wing at least partly surrounded by wing veins.

CHLORINATED HYDROCARBON INSECTICIDE. A chemical compound consisting of carbon, hydrogen and chlorine with insecticidal properties.

COCOON. A silken or parchment-like case made by the larvae of some insects inside which pupation takes place.

CONVEX. Rounded outwardly.

CORNICLE. One of two dorsal posterior abdominal processes on aphids.

CROSS-POLLINATION. The pollination of a plant by pollen of a different plant.

EGG POD. A number of eggs held together in a mass.

ELYTRON (pl. elytra). The thickened front wings occurring on beetles.

EMULSION FORMULATION. A liquid preparation which will mix readily with water.

EXUVIAE. The cast skin of a larva or nymph.

FAMILY. A subdivision of an order containing a group of related genera.

FRASS. The excrement left by an insect larva such as by the wheat stem sawfly within the wheat stem.

FUNGUS DISEASE. A disease caused by a fungus—a low form of plant life which lives off dead or living plant or animal matter.

GENERATION. From egg to egg or a complete life cycle.

GENUS (pl. genera). A group of closely related species.

GROUND SPRAY. A spray applied directly upon the surface of the ground.

HALTERES. Two small knobbed structures replacing the hind wings in Diptera.

HEAD. The first body division of an insect bearing the antennae, eyes and mouth parts.

HIBERNATE. To pass the winter in a dormant state.

HONEY. A sweet edible product made from nectar collected normally from flowers by worker honey bees and stored as food.

HONEYDEW. A sweetish liquid discharged from an aphid.

HOPPERBURN. A diseased condition of potato foliage associated with the feeding of the potato leafhopper.

HOST PLANT. A plant which an insect species prefers.

INSECTICIDE. A chemical which will kill insects either by ingestion, contact or by being inhaled.

INSTAR. The stage or period between successive insect molts.

LARVA (pl. larvae). The second stage in the life history of an insect which has complete metamorphosis (4 stages).

LOW VOLUME SPRAYER. A sprayer which will deliver as little as five gallons of liquid spray per acre.

MAGGOT. The second stage in the life history of some Diptera; also called a larva.

MEMBRANOUS. Thin and usually nearly transparent.

METAMORPHOSIS. Change in form during development from egg to adult.

MM. A millimeter which is approximately one twenty-fifth of an inch.

MOLT. The act of shedding the skin or cuticula of an insect.

NECTAR. A sweet fluid normally secreted by flowers which may be gathered by honey bees and elaborated by them into honey.

NODE. The slightly enlarged portion of the plant stem where leaves and buds arise.

NODULE. A swelling occurring on the root of leguminous plants.

NYMPH. The second stage in the life history of an insect which has simple metamorphosis (3 stages).

ORDER. A subdivision of the class Insecta containing a group of related families.

OVIPOSITOR. The egg-laying structure which may extend beyond the end of the abdomen of the female insect.

PARASITE. An insect that lives in or on and derives its food wholly or in part from another insect.

POLLEN. The spores or grains borne by the anthers of flowering plants, containing the male element.

POLLEN BASKET. That part of the leg of a bee on which the pollen is carried to its nest.

POLLEN BRUSH. A brush of short stiff hairs used in collecting pollen by bees.

POLLINATOR. An insect which transfers pollen from flower to flower.

PREDATOR. An insect which attacks and feeds on other insects.

PREOVIPOSITION PERIOD. The period of time in the adult female insect's life elapsing before she begins to lay eggs.

PROBOSCIS. The extended combined mouth parts of an insect adapted for sucking.

PROLEG. A leg on the abdomen of the larva of some insects.

PRONOTUM. The front part of the top of the thorax of an insect.

PUPA (pl. pupae). The third or resting stage in the life history of an insect which has complete metamorphosis (4 stages).

PUPARIUM (pl. puparia). A case formed by the hardening of the next to the last larval skin in which the pupa is formed in some Diptera.

PUPATE. To change to a pupa.

QUEEN. The mother honey bee of the colony.

SCUTELLUM. A triangular-shaped area behind the pronotum on some insects.

SELF-FERTILE. When pollen from the anther of a flower will fertilize that same flower.

SELF-POLLINATION. The transference of pollen from the anther of one flower to the stigma of the same flower or to the stigma of another flower on the same plant.

SELF-STERILE. When pollen from the anther of a flower will not fertilize the same flower or another flower on the same plant.

SPECIES. A group of individuals similar in structure, appearance and habit.

STEM-MOTHER. The aphid which hatches from an overwintered egg.

STIGMA. The part of the flower to which the pollen adheres.

SUBANAL PLATE. A chitinous plate or process underlying the genital organs at the posterior end of the abdomen of a grasshopper or other insect.

THORAX. The second or middle body division of an insect bearing the true legs and the wings if present.

TIBIA (pl. tibiae). The more slender part of the leg between the femur and the tarsus.

TOXICANT. Anything possessing poisonous qualities.

TRUE LEG. A leg on the thorax of an insect either in the adult, nymphal or larval stage.

TUBERCLE. A small knob-like growth.

VEIN. A chitinous, rod-like structure supporting and stiffening the wing in insects.

VIRUS. An infectious agent too small to be seen even with the aid of an ordinary high power microscope.

WORKER. A sexually undeveloped female honey bee structurally modified for gathering nectar and pollen.

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